N6CD1

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SANTA BARBARA, CA

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1959

Dr. Wilhelm Arnold

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Introduction

1-1. DESCRIPTION.

The TR-7 is a solid-state, broadband, SSB/CW/AM transceiver which embodies several unique state-of-the-art design features. Due to its unique design, the TR-7 offers excellent sensitivity and selectivity, very high dynamic range, digital frequency readout combined with general coverage receive capability, and exceptionally high transmitted signal quality.

Front panel pushbuttons allow the operator to select any of four receiver selectivities without affecting transmitter operation. Standard bandwidth is 2.3 kHz, and other bandwidths are established using easily installed optional crystal filters. In transmit, the standard 2.3 kHz crystal filter is automatically selected to insure proper signal characteristics.

The front panel passband tuning (PBT) control is a valuable aid in reducing or eliminating interfering signals. The PBT control electronically shifts the receiver intermediate frequency (IF). In addition, the beat frequency oscillator (BFO) frequency is simultaneously shifted, thus maintaining the operating frequency to which the receiver is tuned. Since the crystal filter passband is fixed, this allows the operator to electronically move interfering signals out of the receiver passband, providing maximum utilization of the excellent selectivity characteristics afforded by the eight pole crystal filters.

A high level double balanced mixer is used as the first receiver mixer in an up-conversion mode. The use of this device assures the reduction of both front-end overload and intermodulation to a minimum. Careful attention to filter matching and losses in the input circuit keeps the receiver noise figure low to insure good sensitivity.

The TR-7 features a high-stability linear permeability tuned VFO and frequency synthesizer for accurate frequency control. Both analog and digital frequency readouts are featured for maximum operator convenience and flexibility. The digital readout circuitry features a store function. This function, selected by front panel pushbutton, allows the operator to store a frequency on the six-digit front panel LED display for later reference. In addition, two other pushbutton controls allow the TR-7 synthesizer to be stepped up or down in frequency in 500 kHz increments, thus allowing continuous frequency coverage from 1.5 to 30 MHz.

Transmit operation is automatically inhibited in any range not including a legitimate amateur band. An accessory programming board, the AUX-7, is available for out-of-band operation and/or fixed frequency operation such as MARS, reception from 0 through 1.5 MHz, future amateur bands, etc. The digital display can also be used as a 15 MHz frequency counter, if desired.

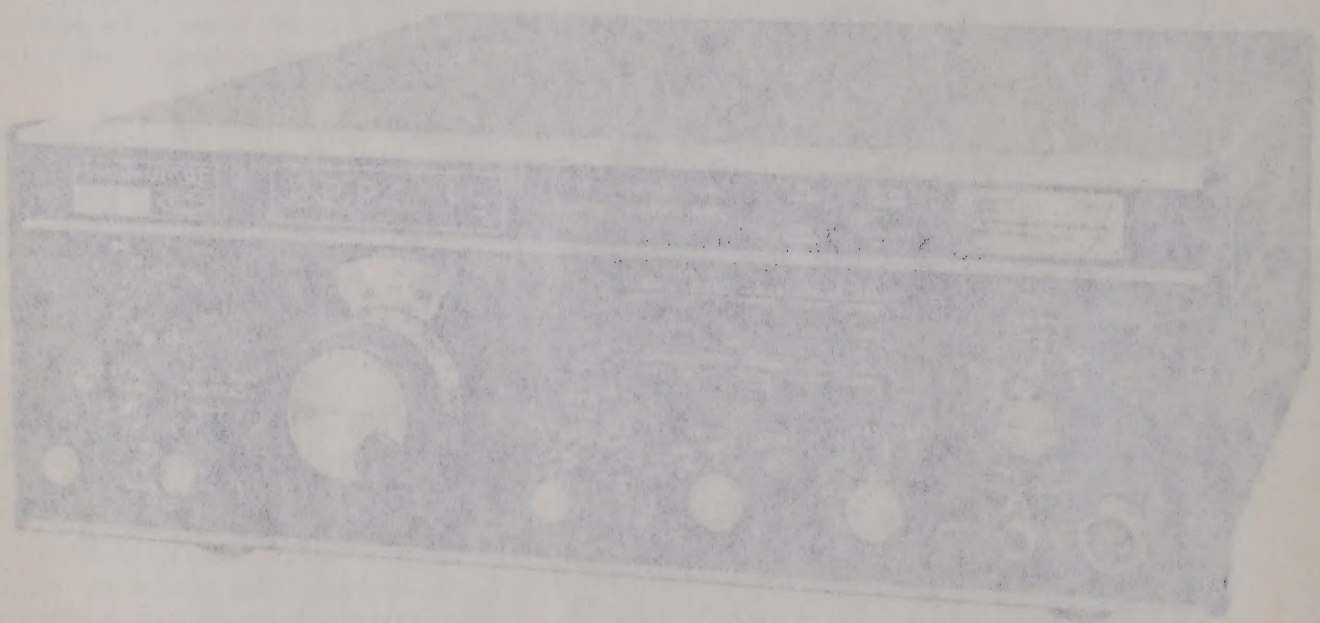
The transmitter section of the TR-7 features a rugged, solid-state power amplifier section which has been designed for continuous duty in the SSB and CW modes. For more demanding duty cycles, such as SSTV or RTTY, the Model 1529 FA-7 cooling fan is available. The transmitter section also features very low harmonic and spurious output, and is equipped with automatic high VSWR protection.

The VOX controls for the TR-7 are located on the front panel, and feature separate delay controls for CW and SSB. VOX operation can be disabled with a front panel pushbutton.

Other features include a built-in directional wattmeter, selectable receiver AGC time constant, built-in 25 kHz calibrator, receiver incremental tuning (RIT), provision for an accessory noise blanker (NB-7), and transceive operation with a companion receiver.

The modular construction of the TR-7 reduces service time to a minimum. Each module is designed to perform a specific function, thus simplifying any required alignment and troubleshooting.

Figure 1-1. TR-7 H. F. Transceiver



GENERAL

Frequency Coverage:
(With DR-7 Digital Readout/General Coverage Board)

Receive:
- Without AUX-7: 1.5 to 30 MHz, continuous.
- With AUX-7:* Same, plus 0 to 1.5 MHz at reduced performance. *(0 to 1.5 MHz Receive only)*

Transmit:
- Without AUX-7: 1.5-2.0, 3.5-4.0, 7.0-7.5, 14.0-14.5, 21.0-21.5, 28.0-30.0 MHz.
- With AUX-7:* Above ranges, plus any eight 500 kHz segments between 1.5 and 30 MHz.

(Without DR-7 Digital Readout/ General Coverage Board) 1.5-2.0, 2.5-3.0 (Receive only), 3.5-4.0, 5.0-5.5 (Receive only), 7.0-7.5, 14.0-14.5, 21.0-21.5, 28.5-29.0 MHz plus 8 additional 500 kHz ranges with AUX-7.*

NOTE

Proof of license or other F.C.C. authorization must be submitted in order to obtain range modules which allow transceive operation outside an amateur band.

*AUX-7 requires use of appropriate Range Modules.

Modes of Operation: USB, LSB, CW, RTTY, AME (A-3H).

Frequency Stability: Total drift is less than 100 Hz after warm-up. Total frequency change is less than 100 Hz over the 11-16 VDC input supply range.

Frequency Readout Accuracy:
- Analog: Better than ±1 kHz when calibrated at the nearest marker point.
- Digital: 15 ppm ±100 Hz.

External Counter Mode:
- Maximum Input Frequency: 150 MHz.
- Input Level Range: 50 mV to 2V , rms.

Power Supply Requirements: 11-16 VDC (13.6 VDC nominal), 3A receive, 25A transmit.

Dimensions:
- Depth: 12.5 in. (31.75 cm), excluding knobs and connectors.
- Width: 13.6 in. (34.6 cm).
- Height: 4.6 in. (11.6 cm), excluding feet.
- Weight: 17.1 lb. (7.75 kg.).

RECEIVER

Sensitivity (1.8-30 MHz):	
SSB, CW:	Less than 0.5 uV for 10 dB $\frac{S+N}{N}$
(Typically .25μV on 15m & 10m bands)	
AM (30% Mod.):	Less than 2.0 uV for 10 dB $\frac{S+N}{N}$
AGC:	Less than 4 dB output variation for 100 dB input signal change, referenced to AGC threshold.
Selectivity:	2.3 kHz at -6 dB and 4.1 kHz at -60 dB. (1.8:1 shape factor).
Ultimate Selectivity:	Greater than 100 dB.

**60 dB 1st. IF rejection from 22-30 MHz.*

Intermodulation:	
Intercept Point:	+20 dBm.
Two-tone Dynamic Range:	95 dB.
IF Frequency:	
First IF:	48.05 MHz.
Second IF:	5.645 MHz.
Image and IF Rejection:	Greater than 80 dB.*
Spurious Response:	Greater than 60 dB down.
Internally Generated Spurious:	Less than 1 uV equivalent, except 3 uV equivalent from 5 to 6 MHz.
Audio Output:	2.0 watts @ less than 10% THD (4 ohm load).

TRANSMITTER

Power Input (Nominal):	
SSB:	250 watts PEP.
CW:	250 watts.
AME (A-3H)	80 watts (carrier), plus upper sideband.
Load Impedance:	50 ohms, nominal.
Spurious Output:	Greater than 50 dB down.
Harmonic Output:	Greater than 45 dB down.
Intermodulation Distortion:	30 dB below PEP. (24 dB below one of two tones.)
Carrier Suppression:	Greater than 60 dB.
Undesired Sideband Suppression:	Greater than 60 dB @ 1 kHz.

Duty Cycle:	
SSB, CW, AM:	100%.
Tune, SSTV, RTTY: w/o FA-7 Fan:	33%, 5 minutes transmit, maximum.
with FA-7 Fan:	100%.
Microphone Input:	High impedance.
Wattmeter Accuracy:	±5% @ 100 watts (50 ohm load).
VSWR Turndown (Nominal):	
@ 1:1 :	0%
@ 2:1 :	10%
@ 3:1 :	25%
@ 4:1 :	50%
@ 5:1 and Above:	90%

1-2. ACCESSORIES.

The following accessory items provide additional operating capability and flexibility for the TR-7, and are available through R. L. Drake Company dealers.

A. C. POWER SUPPLY PS-7, MODEL 1502

Fixed station operation of the TR-7 requires a power supply capable of delivering 13.6 VDC at 25 amperes. The PS-7 power supply meets this requirement, and is packaged in an attractive enclosure similar to the TR-7. It may be placed on the operating desk, but is supplied with sufficiently long interconnecting cables to allow remote location on the floor. Additionally, the PS-7 offers shutdown protection if the current or voltage outputs exceed safe limits. A complete operators' manual, listing specifications and recommended operating procedures, is supplied with the unit.

COOLING FAN FA-7 , MODEL 1529

Severe duty cycle applications of the TR-7, such as extended SSTV or RTTY transmissions require the use of external cooling air on the power amplifier heat sink. The Model 1529 FA-7 Cooling Fan has been matched to the TR-7 cooling air requirements, and features quiet operation and convenient installation. Full installation instructions are supplied with the unit.

NOISE BLANKER NB-7, MODEL 1537

Provision has been made in the TR-7 for plug-in installation of the NB-7 Noise Blanker. The NB-7 is useful in eliminating or reducing impulse noise (such as ignition noise) and some other types of interference (such as LORAN). Complete operating and installation instructions are supplied with the unit.

REMOTE VFO RV-7, MODEL 1338

The RV-7 Remote VFO offers the operator a high degree of frequency control flexibility. The RV-7 can be selected for transmit, receive or transceive frequency control or can be turned off to allow transceive frequency control from the TR-7. For added convenience, the TR-7 RIT control is applied to the RV-7 in the receive mode. The RV-7 also contains a pushbutton controlled "spot" function for easy zero-beat. The unit is housed in an enclosure which is styled to match the TR-7, and is supplied with complete operating and installation instructions.

AUXILIARY PROGRAM BOARD AUX-7, MODEL 1536

The AUX-7 Auxiliary Program Board is a plug-in unit which allows the user to program up to 8 auxiliary 500 kHz frequency ranges for instant selection from the front panel of the TR-7. Possible applications include MARS operation, WWV reception, and zero through 1.5 MHz receive. In addition, a crystal socket is provided for each of the eight auxiliary ranges to allow fixed frequency receive and/or transmit within a selected range.

For receive only applications, programming is accomplished by using one RRM-7 Range Receive Module per band segment. For transceive operation, one RTM-7 Range Transceive Module per band segment is required.

NOTE

Proof of license or other F.C.C. authorization must be submitted in order to obtain RTM-7 Range Transceive Modules.

The AUX-7 is supplied with complete installation, programming and operating instructions.

EXTERNAL SPEAKER MS-7, MODEL 1531

The MS-7 External Speaker is intended for use in lieu of the speaker built into the TR-7 in fixed station operation. The unit is housed in an enclosure which is styled to match the TR-7 in appearance. The impedance of the MS-7 is 4 ohms, and connection to the TR-7 is accomplished via a single plug.

DESK MICROPHONE, MODEL 7077

The Model 7077 Desk Microphone is designed to match the audio characteristics of the TR-7. The unit features a convenient desk stand and PTT or VOX operation. Complete operation and installation instructions are provided.

PORTABLE/MOBILE MOUNTING KIT MMK-7, MODEL 1335

Provides the necessary brackets, mounting hardware and cabling for mobile installation of the TR-7. In addition, a new cabinet for the TR-7 is supplied which features a built-in carrying handle. The MMK-7 includes complete installation and operating instructions.

ANTENNA MATCHING NETWORK MN-7, MODEL 1538

Matches long wire and coax fed antennas on all bands, 160—10 meters. Optional Model 1510 Drake B-1000 balun allows use of balanced feed-lines and/or wide impedance range flexibility. The MN-7 handles 250 watts of input power and features a built-in rf wattmeter/VSWR bridge. A built-in antenna switch allows the selection of up to 3 antennas from the front panel.

ACCESSORY CRYSTAL FILTERS

Several accessory crystal filters are available for the TR-7 as follows:

MODEL	6 dB BAND-WIDTH	60 dB BAND-WIDTH	USE
7024 (Drake SL6000)	6 kHz	12 kHz	AM
7023 (Drake SL1800)	1.8 kHz	3.6 kHz	SSB, RTTY
7022 (Drake SL500)	0.5 kHz	1.1 kHz	CW
7021 (Drake SL300)	0.3 kHz	0.7 kHz	CW

These filters may be easily installed in the TR-7 in any combination of three units. Each filter is supplied with complete installation instructions.

Installation

2-1. UNPACKING.

Carefully remove the TR-7 from the shipping carton and examine it for evidence of damage. If any damage is found, immediately contact the transportation company responsible for delivery of the unit or return the unit to the dealer where the unit was purchased. Keep the shipping carton and all packing material for the transportation company to inspect. The original carton and packing material will make it much easier to return the unit, if necessary. Inspect the packing material for any accessories or printed matter before storing. Locate the registration card, fill out immediately, and return to the R. L. Drake Company to insure registration and validation of the warranty.

2-2. LOCATION.

The location of the TR-7 is not critical. However, care should be taken to insure that adequate clearance is provided to allow free circulation of air around the power amplifier heat sink. Do not cover the vents on top of the cabinet with books, papers, or other equipment as overheating may result.

In addition, if a separate external speaker will not be used, be sure to provide clearance around the opening on the left-hand side of the cabinet to insure adequate sound dispersion.

2-3. MOBILE INSTALLATION.

An accessory mobile mounting kit, the MMK-7, is available for mobile installation of the TR-7. The MMK-7 contains all necessary hardware and cables for mobile operation of the TR-7, and also includes detailed instructions covering installation and operation in a mobile or portable environment. The MMK-7 also includes an alternator whine filter and power line fuse for mobile applications.

The following paragraphs cover antenna, power, microphone, and speaker requirements for mobile installation.

2-3.1. ANTENNA REQUIREMENTS.

Install the mobile antenna as recommended by the antenna manufacturer. Connect a 50 ohm coaxial cable from the antenna to the SO-239 antenna connector at the rear of the TR-7. Pay close attention to the antenna manufacturer's instructions for tuning and matching to insure proper operation of the TR-7.

2-3.2. POWER REQUIREMENTS.

CAUTION

Operation of the TR-7 with an incorrect power source will result in serious damage and may void the warranty.

Operating voltage for the TR-7 is 11 to 16 VDC. Voltages outside this range may either damage the transceiver or cause improper operation. The nominal recommended operating voltage is 13.6 VDC at a current of 3 amperes in receive and 25 amperes peak in transmit.

The rear panel power connector (P-404-AB) has a mating receptacle (S-404-CCT) which is polarized. See figure 2-1 for proper connections, and figure 2-2 for rear panel connector locations. Be sure to wire the power connector exactly as shown to avoid damage to the transceiver. It is recommended that #10 stranded wire be used to wire the power connector directly to the vehicle battery, and that a fuse or circuit breaker rated at 30 amperes be installed in the positive supply line close to the battery.

A defective generator or alternator diode may cause excessive generator noise or alternator whine. Defective ignition wiring or components may result in an undesirable level of ignition noise in the receiver. Reference texts such as the *ARRL Handbook* provide additional details on treating these problems.

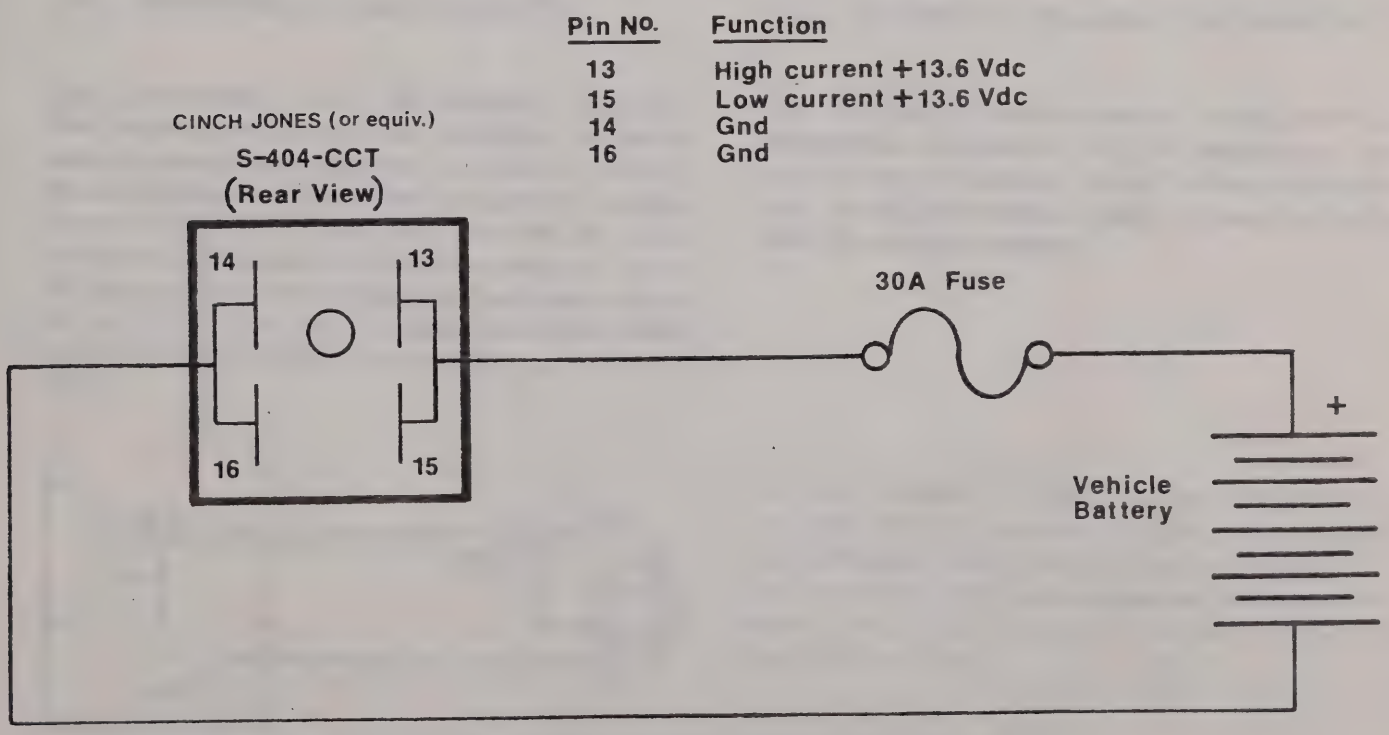


Figure 2-1. TR-7 Power Connection

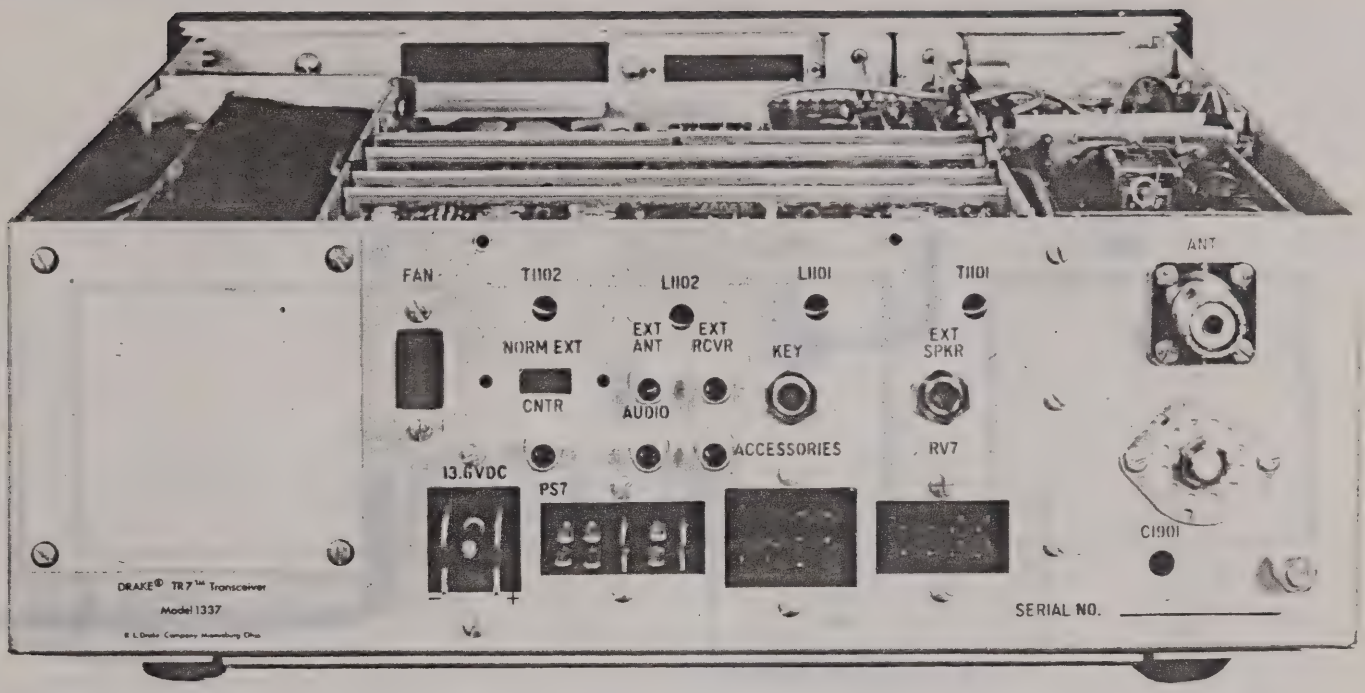


Figure 2-2. TR-7 Rear Panel

2-3.3 MICROPHONE REQUIREMENTS.

Use a microphone with a flat frequency response. The microphone should have a cardiod pattern to reduce pickup from the back and sides. Connect the microphone as illustrated in figure 2-3, using a Drake #329-1055 connector. The use of a pre-amplified microphone is not recommended, due to the possibility of overdriving the input audio stages of the TR-7. The Drake Model 7073 DM microphone is ideally suited for mobile use with the TR-7.

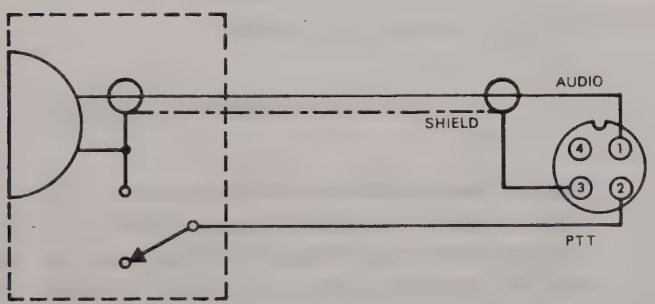


Figure 2-3. TR-7 Microphone Connection

2-3.4. EXTERNAL SPEAKER REQUIREMENTS.

The TR-7 has a built-in speaker. In high noise environments, however, it may be desirable to employ an external speaker located close to the operator. Use of an external speaker automatically disables the internal speaker.

DO NOT connect the TR-7 to the speaker of the car radio. Install a separate 4 ohm speaker capable of handling at least 2 watts of audio. See figure 2-2 for location of the external speaker jack, which accepts a standard 2-circuit phone plug wired such that the tip is 'hot'.

1 – GR
2 – R
3 – BK

2-4. FIXED STATION INSTALLATION.

See figures 2-4 and 2-5 for various configurations of TR-7 fixed station installations.

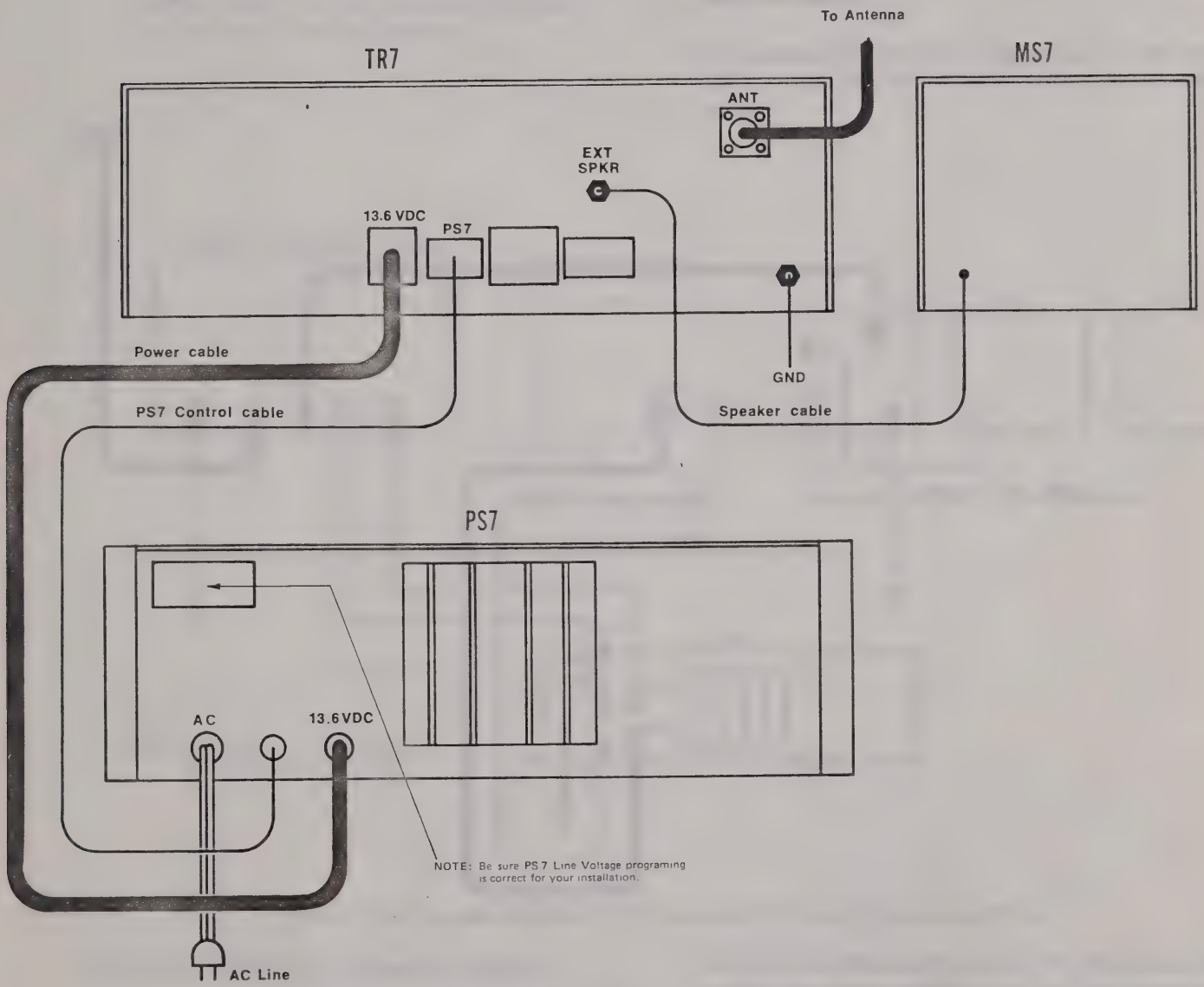
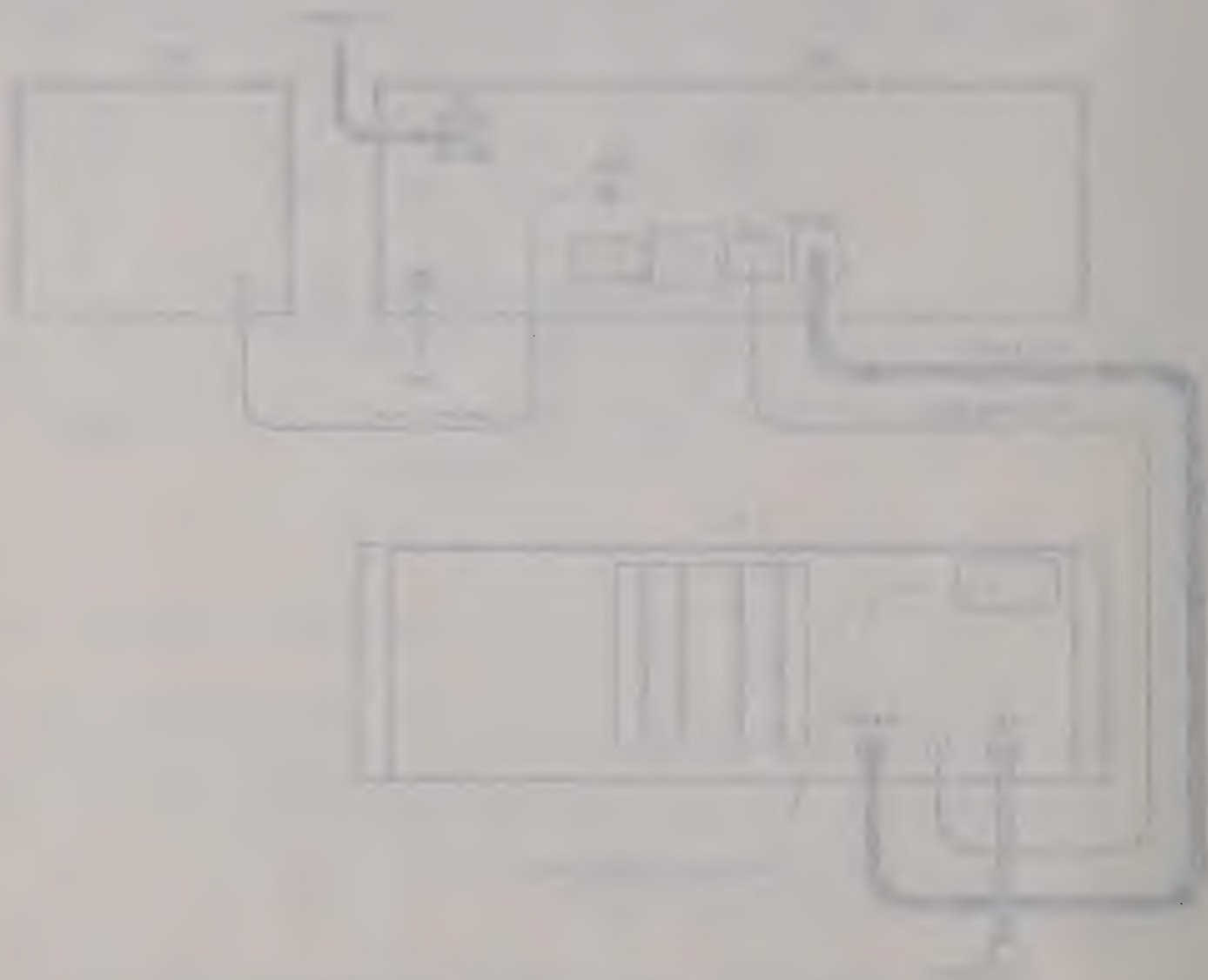


Figure 2-4. Connecting the PS-7 Power Supply and MS-7 Speaker

2-4.1. ANTENNA REQUIREMENTS.

The TR-7 is designed for use with antenna systems having a nominal impedance of 50 ohms. Care should be exercised to reduce the VSWR to the lowest possible value for best operation. If the VSWR exceeds 2:1, the transmitter output power will be reduced in accordance with the table shown in the SPECIFICATIONS section of this manual. When using antennas which do not present a low VSWR, the use of a matching network such as those manufactured by the R. L. Drake Company is recommended. Additional information on antennas can be found in reference texts such as the *ARRL Handbook.*



2-4.2. POWER REQUIREMENTS.

CAUTION

Operation of the TR-7 with an incorrect power source will result in serious damage and may void the warranty.

The PS-7 A.C. Power Supply is recommended for fixed station operation. It is designed to accommodate all operating requirements presented by the TR-7, and provides automatic overvoltage and overcurrent protection. See figure 2-4 for interconnection details.

For general information regarding power sources other than the PS-7, see section 2-3.2 of this manual.

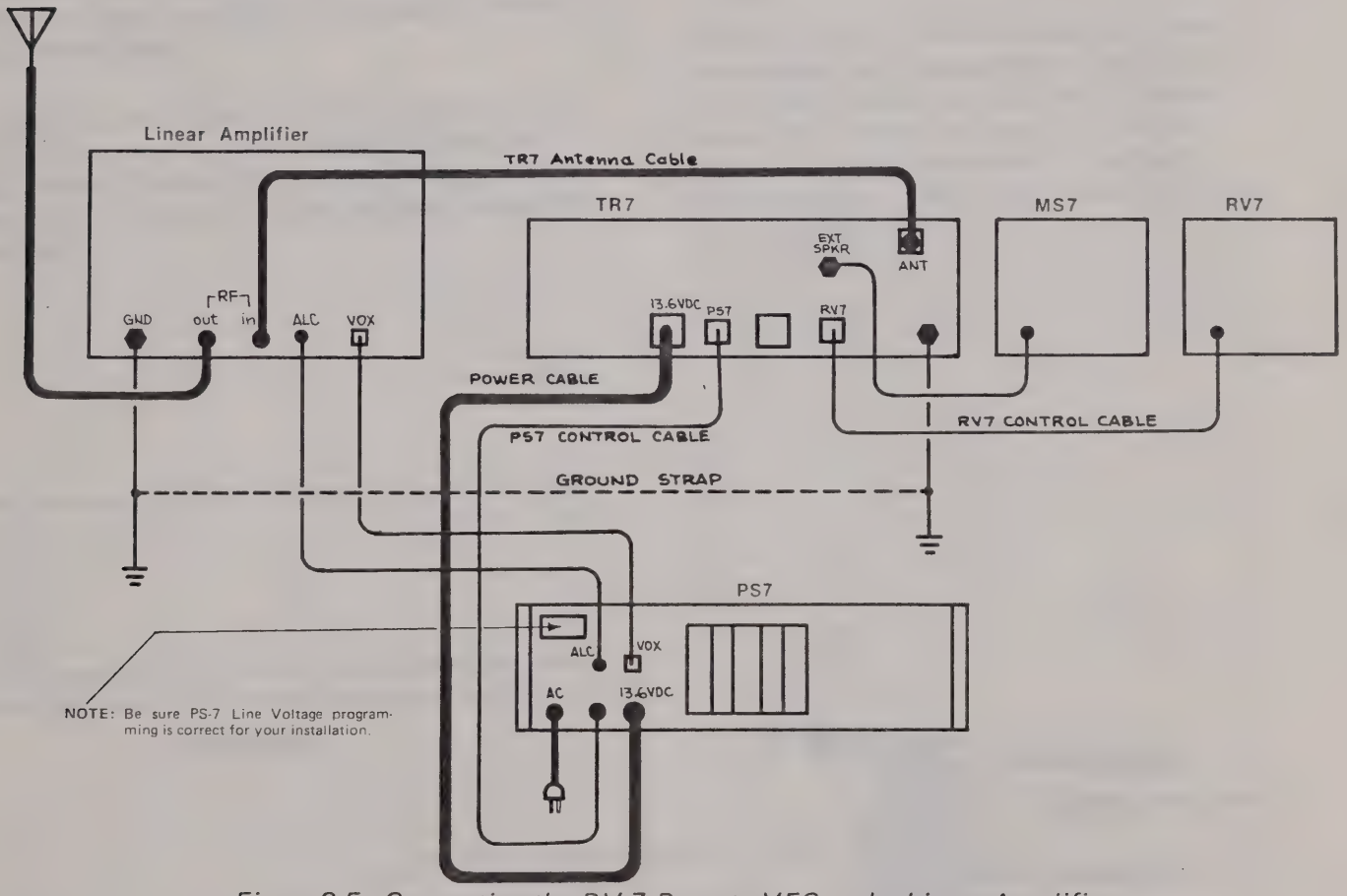


Figure 2-5. Connecting the RV-7 Remote VFO and a Linear Amplifier

2-4.3. MICROPHONE REQUIREMENTS.

The R. L. Drake Model 7077 Desk Microphone is recommended for use in fixed station applications. The unit is supplied wired with a mating connector for the TR-7.

The front panel MIC connector has been wired to accommodate two types of microphones. For use with a dynamic microphone, such as the Drake Model 7077, the connections should be made as shown in Figure 2-3 of this manual. For a high output, high impedance crystal or ceramic microphone, such as the Astatic Model D-104, the microphone audio should be wired to pin 4 of the connector instead of pin 1. Pin 4 presents an input impedance of approximately 750 K ohms, and is 8 dB less sensitive than the pin 1 input.

If your operating habits are such that you 'close talk' a microphone, or if you have a very loud speaking voice, you may find it beneficial to rewire a dynamic microphone such as the Model 7077 by moving the audio lead from pin 1 to pin 4 inside the microphone connector. This will eliminate the chances of overdriving the TR-7 audio input in these instances.

2-4.4. EXTERNAL SPEAKER REQUIREMENTS.

The TR-7 contains a built-in speaker; however, this speaker is located on the left-hand side of the radio. In many installations where the TR-7 is placed directly alongside other equipment, the built-in speaker output will be blocked. In these instances, an external speaker is recommended. The MS-7 Matching Speaker is designed for this application. See figure 2-2 for location of the external speaker jack.

If a speaker other than the MS-7 is used, be sure that it is a 4 ohm speaker, capable of handling at least 2 watts of audio. The internal TR-7 speaker is automatically disabled when an external speaker is connected.

2-4.5. VIEWING ANGLE.

Refer to figure 2-6 for illustrations of viewing angle options. In order to change mounting feet, remove the bottom cover by removing the ten screws around the edge of the cover. Carefully slide the cover off toward the back of the TR-7. Reinstall the cover by reversing this process.

CAUTION

Be sure that all power is removed before attempting any disassembly of the TR-7. Potentially lethal voltages are exposed when the covers are removed. It is suggested that all accessories be unplugged from the TR-7 before attempting to remove the covers.

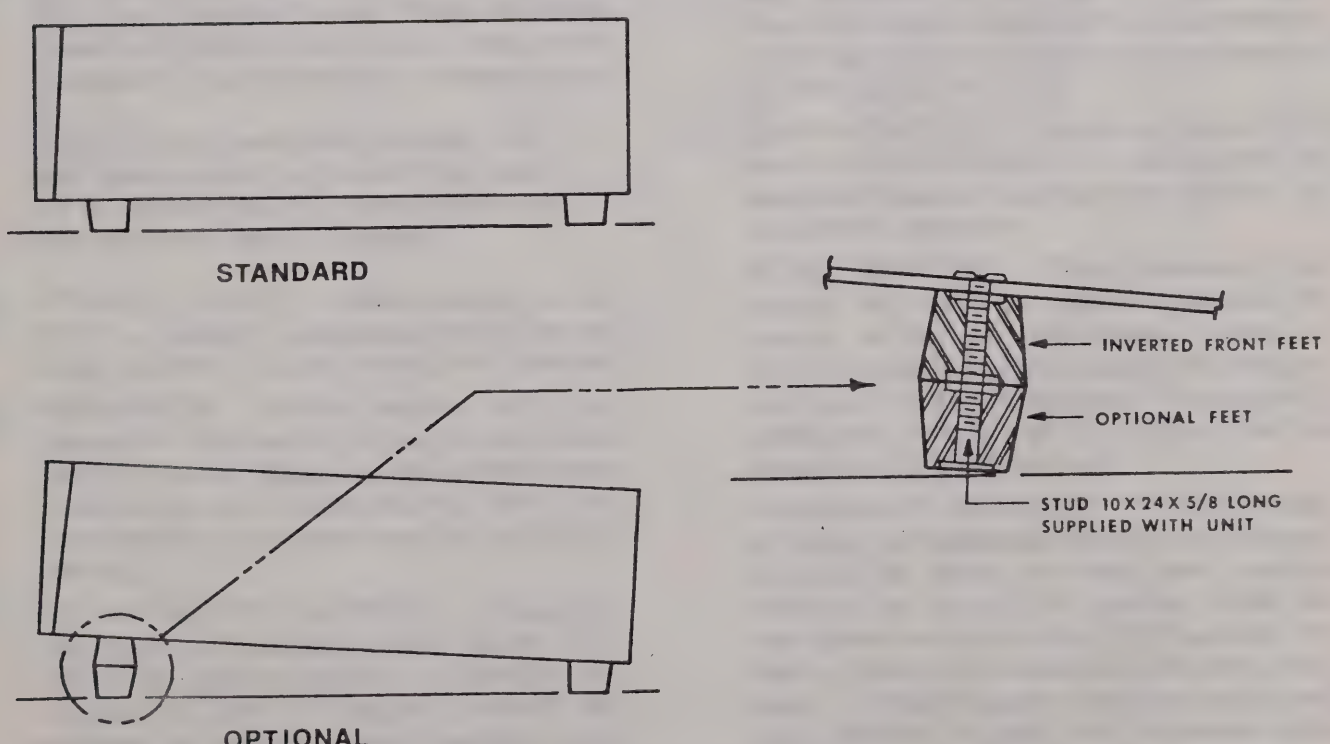


Figure 2-6. Viewing Angle Options

3-1. FRONT PANEL CONTROLS AND CONNECTIONS.

The following paragraphs describe all front panel controls and connections. Refer to figure 3-1 for the location of individual controls.

A. METER — Indicates relative level of received signals in receive mode. Indicates forward or reflected power output in transmit mode.

TR-7 'S' meter readings may not agree with other receivers due to differences in overall gain distribution. Such discrepancies are not indicative of relative sensitivity.

B. STATUS INDICATORS —

1. Fixed — Indicates fixed transmit and/or receive mode has been selected.
2. Set Band — Indicates the need to set the bandswitch to the proper range when using AUX-7 accessory.
3. RIT — Indicates that RIT is enabled.
4. PBT — Indicates that the front panel PBT control has control of passband positioning on receive, regardless of position of MODE switch.

C. REF/FWD SWITCH — Controls the meter function in transmit mode. With switch out, meter will read forward power. When switch is depressed, meter indicates reflected power.

NOTE: TR-7 wattmeter readings may not agree precisely with other high quality equipment due to slight non-linearities inherent in the TR-7 meter.

D. PTT/VOX SWITCH — When switch is out, VOX is enabled. Depressing the switch disables the VOX circuitry, leaving PTT enabled.

E. F/S SWITCH — Selects receiver AGC time constants. When switch is out, a slow decay time is selected. Depressing the switch selects a fast decay time. Additional AGC time constant tailoring is accomplished by the MODE switch, V.

F. & G. FIXED/VFO SWITCHES — Determine the source of frequency control for the TR-7 when the optional AUX-7 is installed and crystals are used for frequency control. Depressing the switches selects transmit or receive crystal control as labelled. In the out position, the transceiver reverts to VFO control.

NOTE: If crystals are not installed, or the AUX-7 is not installed, these switches must be in the out position for proper TR-7 operation.

H. PBT SWITCH — Selects the front panel receiver passband tuning control in the depressed position. In the out position, the transceiver passband tuning is internally controlled in conjunction with the MODE switch.

I. UP CONTROL — Each time this momentary contact pushbutton is depressed, the TR-7 operating frequency will increase 500 kHz. This action will continue until the upper limit of the selected band range (yellow numbers on BAND switch, Z) is reached, at which point the bandswitch must be reset to allow further increase. Transmission is automatically inhibited in any 500 kHz range which does not contain a legitimate amateur band or which has not been programmed for transmit by the optional AUX-7.

J. DOWN CONTROL — Operation is exactly the same as the UP control (I.), except that the operating frequency is decreased 500 kHz for each switch actuation.

K. STORE CONTROL — When depressed, this control will store the current operating frequency on the six digit display. Control of the operating frequency remains variable, and the analog dial must be used. This feature is useful as a 'scratch pad' for remembering net frequencies, DX stations, etc.

L. FREQUENCY READOUT — Presents a digital display of operating frequency to the nearest 100 Hz when the rear panel counter switch is in the NORM position. When the rear panel switch is in the EXT position, the display reads the frequency (150 MHz maximum) of a signal source connected to the rear panel COUNTER jack. For frequencies over 100 MHz, the hundred MHz digit is implied; i.e.; 146.9400 MHz will be displayed as 46940.0.

Operation

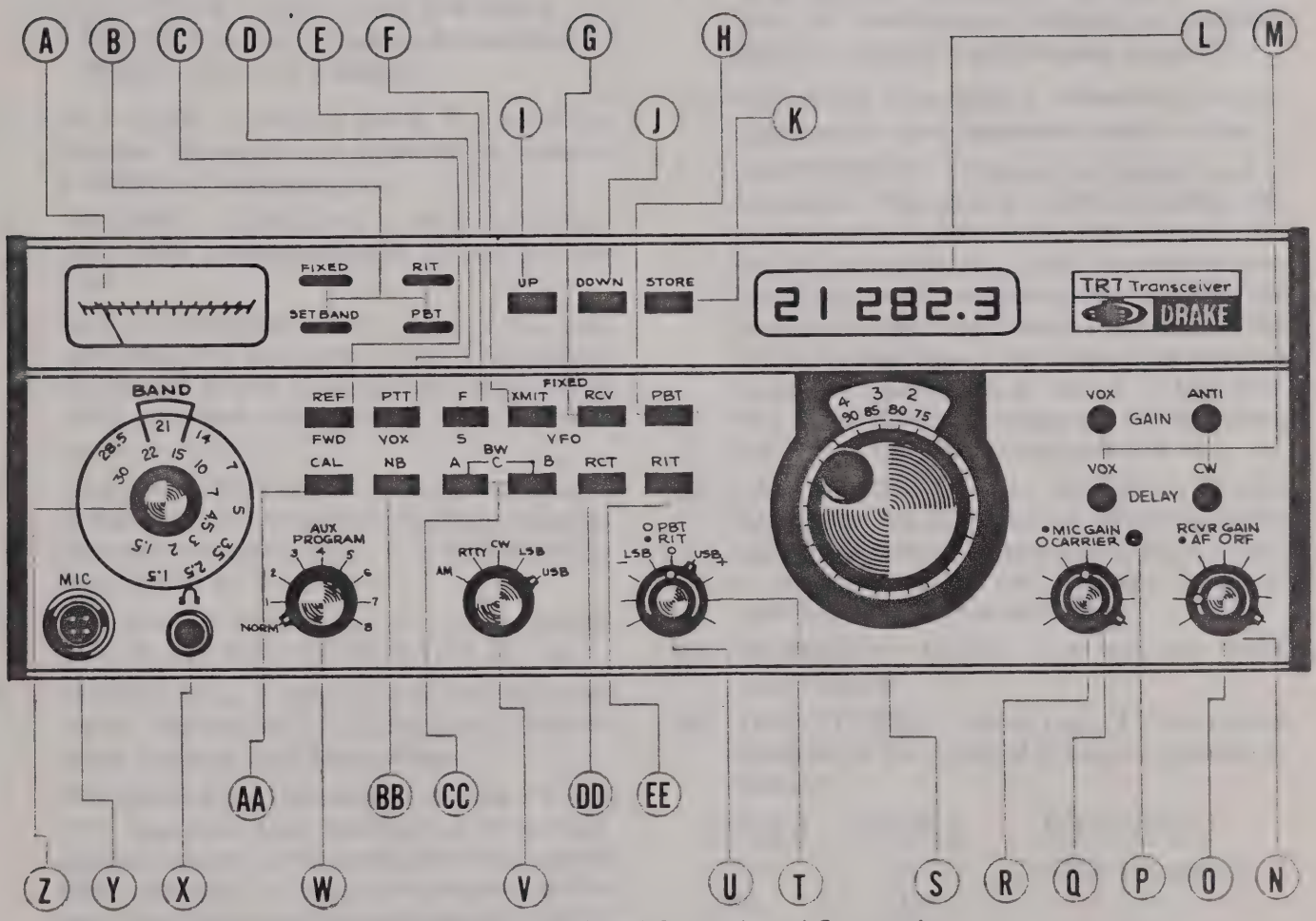


Figure 3-1. Front Panel Controls and Connections

M. VOX CONTROLS — Four VOX controls are provided on the front panel as follows:
   1. VOX GAIN — Adjusts the gain of the VOX amplifier when the PTT/VOX switch is in the out position (VOX operational).
   2. ANTI GAIN — Adjusts the gain of the ANTIVOX amplifier when the PTT/VOX switch is in the out position (VOX operational).
   3. VOX DELAY — Adjusts the VOX release time in the SSB and AM modes. Release time is variable from 0 to 3 seconds.
   4. CW DELAY — Adjusts the CW Delay release time in the CW mode. Release time is variable from 0 to 3 seconds.

N. R. F. GAIN — Controls the R. F. gain of the receiver. Normally used in the fully clockwise position for maximum gain.

O. AF GAIN — Controls the receiver audio gain. Turn fully counterclockwise to turn off the TR-7.

P. ALC INDICATOR — This green LED indicates that the transmitter ALC is controlling the output power. It is used to set up proper audio gain and carrier levels in the transmit mode.

Q. CARRIER CONTROL — Sets the carrier level in the CW and AM modes. Clockwise rotation increases the carrier level. It is deactivated in the SSB and RTTY modes.

R. MIC. GAIN — Adjusts the microphone gain in AM and SSB. Does not affect VOX settings.

S. TUNING DIAL — Adjusts frequency of transceiver. See section 3-3 of this manual for detailed description of dial readings.

T. PBT CONTROL — Shifts the receiver IF and BFO together, thus maintaining a constant receiver operating frequency. Since the crystal filter passband is fixed, this control can be used to position interfering signals outside the receiver passband. When using accessory crystal filters, it may be desirable to use this control to reposition the receiver passband for the most pleasing receiver audio response.

U. RIT CONTROL — When the RIT switch (EE) is depressed, this control allows the receiver frequency to be varied over a nominal ±3 kHz range without affecting the transmit frequency.

V. MODE SWITCH — Selects the desired mode of operation.

W. AUX PROGRAM SWITCH — Selects the desired auxiliary 500 kHz range and/or fixed frequency crystal when the AUX-7 accessory is installed.

NOTE: This control should remain in the NORM position if the AUX-7 is not installed.

X. (HEADPHONES) — Provides a connection for headphones. Internal or external speaker is muted when this jack is used.*

Y. MIC. JACK — Provides a connection for microphone or other transmitter audio source.

Z. BAND SWITCH — Selects the desired band of operation. The yellow numbers within the yellow bracket indicate the total range which can be covered in any given bandswitch position. The white numerals in the center of the brackets indicate the lowest frequency of the 500 kHz range which is automatically selected when the bandswitch is turned to this position. Other 500 kHz ranges are selected using the UP and DOWN pushbuttons (I & J).

AA. CAL SWITCH — Enables the built-in 25 kHz calibrator. Due to the nature of the calibrator signal, it is normal to experience some receiver intermodulation and spurious response when the calibrator is enabled.

BB. NB SWITCH — Enables the optional NB-7 noise blanker.

CC. BW SWITCHES — Select one of four crystal filters when the optional filters are installed as follows:

Switch A	Switch B	Filter Selected
Out	Out	2.3 kHz (Standard)
In	Out	A
Out	In	B
In	In	C

NOTE: The receiver will be inoperative in any BW position which does not have a filter.

DD. RCT SWITCH — Selects a remote transmitter frequency control source. Normally left in the out position.

EE. RIT SWITCH — Enables the front panel RIT control.

* If low impedance headphones are used, a 100 ohm resistor should be installed in series with the phones.

3-2. REAR PANEL CONTROLS AND CONNECTIONS.

A. FAN – 120 VAC outlet for use with Model 1529 FA-7 Fan accessory. Switched by front panel on/off switch when using the PS-7 AC Supply.

B. COUNTER FUNCTION — Switch selects between normal and external modes. External mode converts the display to a 150 MHz frequency counter. Apply the signal to be measured to the indicated jack. Counter sensitivity is 50 mV, and maximum input is 2 V. This feature is useful for accurately setting the frequency of two-meter crystal controlled radios.

C. AUDIO JACK – Connected to the top of the AF GAIN control. As such, this jack can be used for audio input to the receiver audio amplifier or audio output to accessories such as tape recorders or RTTY terminal units. Output level is nominally 0.1 volt at high impedance.

D. EXTERNAL ANTENNA — This jack is normally internally jumpered to the EXTERNAL RECEIVER jack. If a separate receiver antenna is desired, it should be connected to this jack and the internal jumper should be removed. Reverse this process to restore normal operation.

E. EXTERNAL RECEIVER — This jack is normally internally jumpered to the EXTERNAL ANTENNA jack. If a separate receiver is used with the TR-7, the separate receiver antenna terminals should be connected to this jack and the internal jumper removed. Due to the transmit/receive switching configuration necessary for proper operation of the TR-7, the EXTERNAL RECEIVER jack connects to the main antenna through the low-pass filter module (see figure 4-1). Because of this requirement, the operating frequency of the external receiver must be below the upper end of the operating range indicated in yellow numbers on the TR-7 bandswitch.

Reconnect the internal jumper to restore the TR-7 receiver to normal operation.

An external receiver may be muted during transmit by connecting the receiver mute line to pin 11 of the ACCESSORIES connector. Note that this line is grounded in receive and open in transmit; check to be sure that the receiver in use is compatible with such a connection. All receivers manufactured by the R. L. Drake Company can utilize this muting connection.

F. KEY — Connection for key or keyer for CW use. Keyer should be capable of handling a *positive* keyline voltage of 10 VDC @ 1ma. Keyers designed for grid-block keying (negative voltage) will not provide proper operation. Plug should be wired so that the insulated tip is positive and the sleeve is ground.

G. EXTERNAL SPEAKER — Connection for an external 4 ohm speaker rated at 2 watts or more, such as the MS-7. Internal speaker is automatically muted when external speaker is connected. Plug should be wired so tip is 'hot.'

H. ANTENNA — Accepts standard PL-259 coax fitting for connection of main antenna to the TR-7.

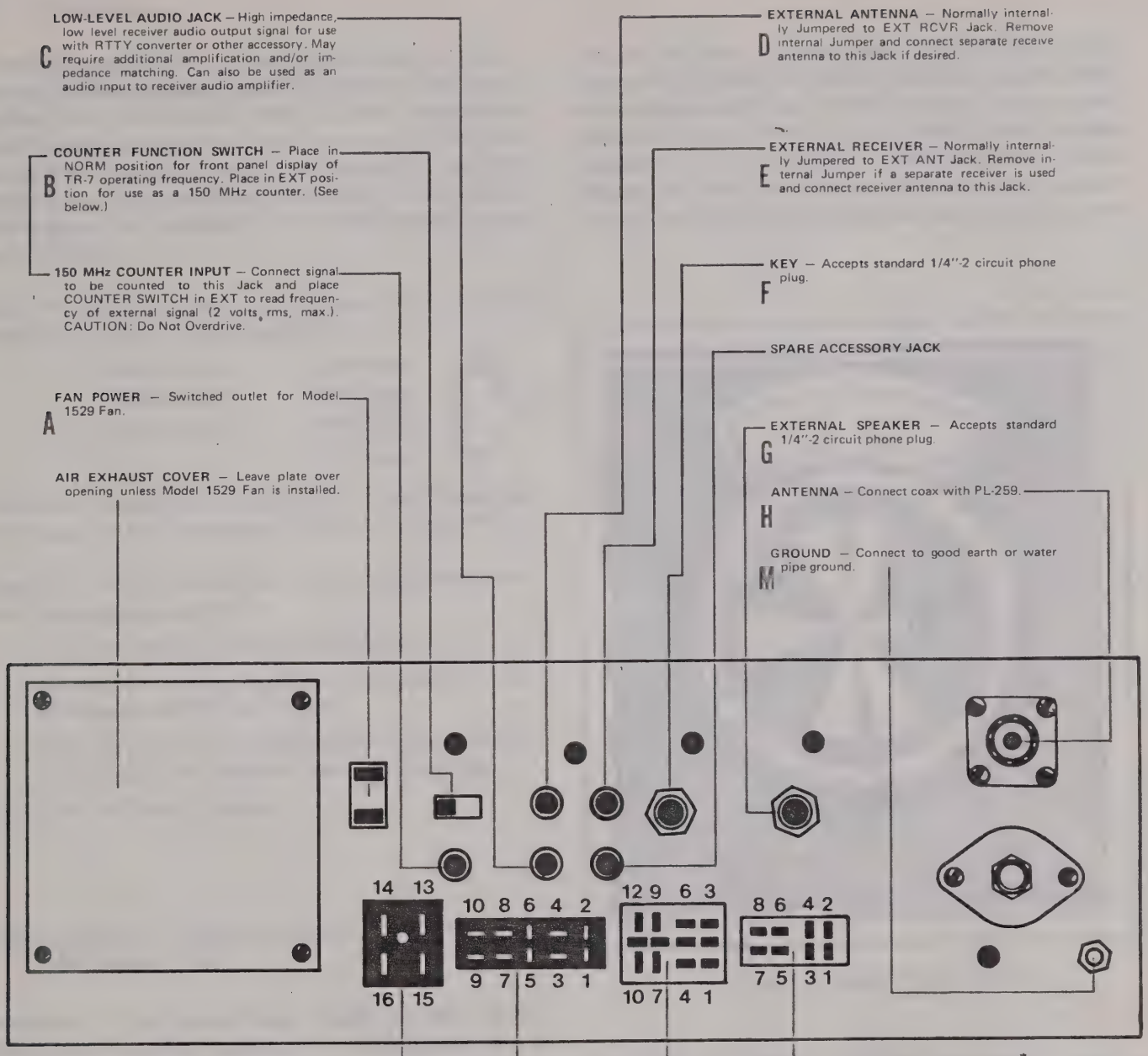
I. POWER INPUT — Mates with a S-404-CCT socket. See figure 2-1 for power connections.

J. PS-7 CONTROL — Mates with a S-310-CCT socket. VOX relay and linear amplifier ALC signals are available at this connector for use with accessories. When using the TR-7 with a PS-7, these signals are available on the rear of the PS-7.

K. ACCESSORIES — Mates with a P-312-CCT plug. This connector provides for a wide range of accessory interconnections.

L. RV-7 — Mates with a P-308-CCT plug. Provides all power, signal and control lines for the RV-7 Remote VFO.

M. GROUND – Connect to a good earth or water pipe ground to insure proper operation of the TR-7.


C
LOW-LEVEL AUDIO JACK – High impedance, low level receiver audio output signal for use with RTTY converter or other accessory. May require additional amplification and/or impedance matching. Can also be used as an audio input to receiver audio amplifier.
B
COUNTER FUNCTION SWITCH – Place in NORM position for front panel display of TR-7 operating frequency. Place in EXT position for use as a 150 MHz counter. (See below.)
150 MHz COUNTER INPUT – Connect signal to be counted to this Jack and place COUNTER SWITCH in EXT to read frequency of external signal (2 volts, rms, max.). CAUTION: Do Not Overdrive.
A
FAN POWER – Switched outlet for Model 1529 Fan.
AIR EXHAUST COVER – Leave plate over opening unless Model 1529 Fan is installed.
D
EXTERNAL ANTENNA – Normally internally Jumpered to EXT RCVR Jack. Remove internal Jumper and connect separate receive antenna to this Jack if desired.
E
EXTERNAL RECEIVER – Normally internally Jumpered to EXT ANT Jack. Remove internal Jumper if a separate receiver is used and connect receiver antenna to this Jack.
F
KEY – Accepts standard 1/4"-2 circuit phone plug.
SPARE ACCESSORY JACK
G
EXTERNAL SPEAKER – Accepts standard 1/4"-2 circuit phone plug.
H
ANTENNA – Connect coax with PL-259.
M
GROUND – Connect to good earth or water pipe ground.
14 13
16 15
10 8 6 4 2
9 7 5 3 1
12 9 6 3
10 7 4 1
8 6 4 2
7 5 3 1

REMOTE VFO – Mates with P-308-CCT*

L

Pin	Function
1	Gnd
2	RV7 PTO
3	+13.6 VDC
4	Transmit disable
5	RV7 PTO enable
6	RIT
7	RV7 Receive
8	RV7 Transmit

POWER INPUT – Mates with S-404-CCT*

I

Pin	Function
13	+13.6 to P.A.
14	Gnd
15	+13.6 to Sw.
16	Gnd

ACCESSORIES – Mates with P-312-CCT*

K

Pin	Function
1	+10 VDC transmit
2	RCT source
3	Gnd
4	RCT source enable
5	RCT indicator enable
6	40 MHz
7	VLF antenna
8	Transmit disable
9	+13.6 VDC
10	PTT
11	VOX relay (Rx mute)
12	NC

PS7 CONTROL – Mates with S-310-CCT*

J

Pin	Function
1	AC from switch
2	AC to switch
3	NC
4	NC
5	NC
6	AC to fan
7	NC
8	VOX relay (linear)
9	ALC input
10	Gnd

*CINCH JONES (or equiv.)

Figure 3-2. Rear Panel Controls and Connections

3-3. VFO DIAL.

This dial consists of two concentric discs, which rotate at different speeds, and the skirt on the main tuning knob. Zero to 100 kHz in 5 kHz increments is indicated on one disc and hundreds of kHz on the other. The knob skirt is calibrated in one kHz increments. The operating frequency is the sum of the frequencies indicated by the BAND switch and the VFO dial.

The VFO dial is illustrated in figure 3-3. In this illustration, the dial is read as follows:

100 kHz dial	.200 MHz
+ 5 kHz dial	.070 MHz
+ Knob skirt	.002 MHz
	.272 MHz

Therefore, adding 0.272 MHz to the BAND setting will result in the operating frequency of the TR-7.

The dial may be calibrated over a short range by the following procedure:

A. Depress the CAL switch (calibrator on).

B. Rotate the tuning knob to the nearest 25 kHz increment (0, 25, 50, or 75).

C. Hold the knob skirt stationary and rotate the knob until the calibrator signal is zero beat.

D. Turn off the calibrator.

3-4. GENERAL OPERATIONAL INFORMATION.

Because of the broadband design of the TR-7, there is no 'tune-up' required. It is desirable, however, that the load presented by the antenna be between 25 and 100 ohms (2:1 VSWR or less). If this is not the case, an antenna tuner can be used to provide the proper match.

In order to provide a carrier output to check VSWR or to adjust an antenna tuner, preset the front panel controls as follows:

MODE:	CW
BAND:	On Desired Range
TUNING:	Set to Desired Frequency
CARRIER:	Fully Counterclockwise
CW DELAY:	Fully Counterclockwise
AF GAIN:	Power On
REF/FWD SWITCH:	Out (FWD)

Plug a key into the rear panel key jack. Close the key and increase the carrier control to get a full scale deflection on the VSWR meter of the antenna tuner or wattmeter. If an external meter is not available, set the carrier control for 10-20 watts output on the TR-7 meter. Follow the manufacturers instructions for adjusting the antenna tuner

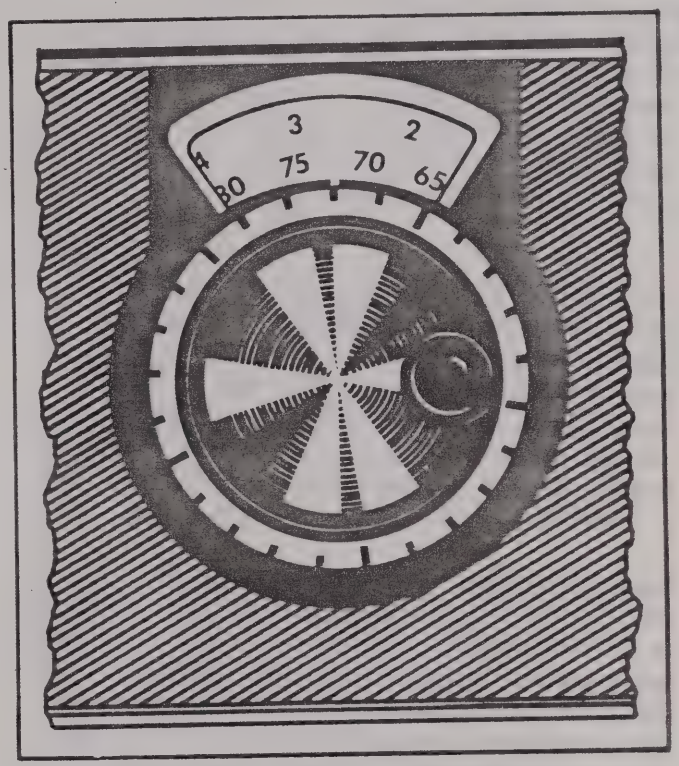


Figure 3-3. Main Tuning Dial

for minimim VSWR. Again, if an external meter is not available, depress the REF/FWD switch to read reflected power on the TR-7 meter. Be sure to observe the 5 minute maximum key-down time to avoid overheating the TR-7 power amplifier.

Once the antenna or tuner has been adjusted at reduced power, increase the carrier level until the green ALC light comes on. Proceed to optimize antenna and/or tuner adjustments, again observing maximum key-down limitations.

If a key is not available for these adjustments, a shorted plug may be inserted in the key jack. If this is done, the TR-7 can be switched from trans-

mit to receive by switching the mode switch from CW to any other mode.

The ALC system in the TR-7 is operative in all modes, and senses both forward and reflected power. As antenna line VSWR increases, the ALC will decrease the power input to the power amplifier to protect the output transistors. Thus, with high VSWR, the ALC indicator will light at lower power outputs, indicating that this circuit is working.

Transmission is inhibited if the TR-7 is not tuned to the correct band or the synthesizer becomes unlocked. In the event that the radio will not transmit, check to be sure that the frequency is correct, that the FIXED and RCT switches are in the out position, and that the AUX PROGRAM switch is in the correct position.

The PBT (Passband Tuning) control may be adjusted to emphasize low or high frequencies on a received signal. The adjustment of this control is largely one of operator preference, and the setting should be the one which produces the most pleasing audio response or minimum interference. When accessory crystal filters are in use, the PBT control can be used to place the receiver passband in the most advantageous position for interference rejection. Note that the setting of the PBT control has no effect on transmitter operation, since the transmitter passband is automatically selected by the MODE switch.

3-5. SSB OPERATION.

In the following discussion, it is assumed that the TR-7 has been matched to the antenna on the desired band as described in paragraph 3-4.

For single sideband operation of the TR-7, preset the front panel controls as follows:

MODE:	On Desired Sideband
BAND:	On Desired Range
TUNING:	Set to Desired Frequency
MIC. GAIN:	Fully Counterclockwise
RF GAIN:	Fully Clockwise
AF GAIN:	Fully Counterclockwise (do not turn off power)
VOX GAIN:	Fully Counterclockwise
ANTI-VOX:	Fully Counterclockwise
VOX DELAY:	Fully Counterclockwise
VOX/PTT SWITCH:	Out (VOX)

While speaking into the microphone in a normal voice, increase the VOX gain control until the TR-7 relay pulls in reliably with speech. Increase the VOX delay control for the desired drop out time. Increase the AF GAIN control until received signals are of the desired level. This may cause the transceiver to cycle back and forth between transmit and receive. Adjust the ANTI-VOX control until the cycling stops. The use of a microphone with a directional pick-up pattern will help to reduce undesired VOX tripping.

Again, speak into the microphone in a normal voice and increase the MIC GAIN control until the green ALC indicator comes on. Additional increase of the MIC GAIN control will not increase power output, and may result in distortion of the transmitted signal. If VOX operation is not desired, depress the VOX/PTT switch and use the PTT switch on the microphone for transmit/receive control.

On SSB, the TR-7 transmits on exactly the same frequency on which it receives (RIT off). Therefore, be sure that you have the signals tuned in so that voices sound normal before transmitting. Otherwise, you will not be transmitting exactly on frequency. Once contact has been established, the RIT control can be enabled and used for minor receive frequency corrections. The digital readout will show the operating frequency on both receive and transmit, thus indicating when reception and transmission are on different frequencies.

3-6. CW OPERATION.

To operate CW, connect a key to the KEY jack. If an electronic keyer is used, connect it for cathode keying; i.e., a *positive* keyline voltage. Wire the keyer plug so that the tip of the plug is 'hot.' Leave the key in the open condition. The TR-7 uses shifted carrier CW. With this system, it is possible to transmit on the received station's frequency without being zero beat while receiving. The transmit frequency is shifted from the receive frequency by approximately 800 Hz. The frequency display reads the correct frequency of a receive signal when the signal is tuned for zero beat.

To receive CW signals, place the MODE switch in the CW position. Tune in a CW signal for an audio pitch of about 800 Hz and adjust the AF GAIN control for a comfortable listening level. If PBT control is in use, it must be positioned in the USB area for on frequency transceive operation.

To transmit, close the key and adjust the CARRIER control until the green ALC indicator comes on. Increasing the CARRIER control further will not increase power output, and may result in undesirable keying characteristics. The CW sidetone level is adjustable with the front panel AF GAIN control.

The TR-7 uses automatic transmit/receive switching. This means that it will automatically transmit when the key is depressed and return to the receive condition when the key is released. The delay time from transmit to receive is adjustable with the front panel CW DELAY control. At minimum delay, the TR-7 allows break-in operation between words at keying speeds up to 20 wpm. Maximum delay is approximately 3 seconds.

Manual transmit/receive switching in the CW mode can be accomplished by connecting an external switch to the push-to-talk circuit of the MIC jack or to pin 10 of the rear panel ACCESSORIES connector.

3-7. AM OPERATION.

For AM operation, place the MODE switch in the AM position. Tune in AM signals for most pleasing audio. This will not necessarily coincide with maximum S-meter reading, particularly when using crystal filters narrower than the accessory 6 kHz filter. To transmit, depress the microphone push-to-talk switch and adjust the CARRIER control for a forward wattmeter reading of 1/3 the output available in the CW mode. For example, if the maximum available output in CW is 150 watts, the CARRIER control should be set for 50 watts output in the AM mode. After setting the carrier level, increase the MIC GAIN while speaking into the microphone. The MIC GAIN should be set at the point where normal speech causes the green ALC indicator to be on. Additional increase in the MIC GAIN setting will result in distortion, so care should be used when making this adjustment. Also, excessive carrier level settings will result in a low percentage of modulation due to the ALC action of the TR-7.

Note that the TR-7 operates in A-3H in AM transmit. This means that only one sideband (the upper) is transmitted with the carrier. This system is fully compatible with all AM receivers, but SSB receivers must be used on USB to properly detect the TR-7 AM transmit signal.

3-8. RTTY OPERATION.

For RTTY operation, place the MODE switch in the RTTY position. The transceiver passband is automatically set to LSB for standard mark-space tones of 2125 and 2295 Hz (narrow shift) and 2125 and 2975 Hz (wide shift) in the RTTY mode. Receive audio for the terminal unit can be taken from the external speaker jack or the rear panel AUDIO connector. If the AUDIO connector is used, care must be taken to provide a high impedance load capable of operation with a 0.1 volt signal.

In transmit, an AFSK signal should be connected to the MIC connector, and the push-to-talk line used to key the transceiver. The VOX circuitry is disabled in the RTTY mode. Adjust the gain controls as described for SSB operation. Care should be taken to observe the maximum transmission time (5 minutes) limit. The model 1529 FA-7 fan accessory is recommended if long RTTY transmissions are contemplated.

3-9. OPERATION NEAR BAND EDGES.

When operating near the edge of an amateur band, be sure that the entire transmitted signal is within the band. On SSB, be sure to use the sideband that will be away from the band edge. On CW, the transmitted carrier will be approximately 800 Hz higher than the indicated dial frequency when the received signal is tuned for zero beat. On AM, the transmitted signal will be as wide as the highest modulating frequency (approximately 3 kHz). The RTTY mode places the mark-space tones on the *lower* side of the carrier (dial) frequency.

3-10. OPERATION WITH A LINEAR AMPLIFIER.

The TR-7 has sufficient output power to drive most linear amplifiers. However, since the TR-7 is

rated at 250 watts PEP input, it is doubtful that it would be worthwhile to use a linear amplifier with a power input rating of less than 1000 to 2000 watts PEP. A triode type grounded grid linear amplifier will present a satisfactory load to the TR-7. See figure 2-5 for typical interconnections.

If the linear amplifier is of the grounded cathode type with high impedance and/or high sensitivity input, it will be necessary to install a resistive pad between the TR-7 and the amplifier input that will present a 50 ohm load impedance to the TR-7. Such a pad must have adequate power handling capability.

Operation in the various modes is exactly as described in previous sections. Follow the instructions provided with the amplifier for tune-up. Care should be taken to avoid overdriving the linear amplifier. If the amplifier has an ALC output, it can be connected to the ALC input on the PS-7 rear panel to prevent overdrive, *provided that the amplifier in use generates a negative ALC voltage.*

The amplifier relay control line should be plugged into the indicated connector on the PS-7. Be sure to observe polarity when connecting the linear amplifier relay control line. Note that one side of this line is ground; if the linear in use requires an isolated set of relay contacts, a separate relay will be required.

NOTE

Be sure that your amplifier presents a 50 ohm characteristic in the standby or bypass mode to avoid activating the VSWR protection circuitry in the TR-7 when operating low power.

3-11. RECEPTION BELOW 1.5 MHz.

The optional AUX-7 Program Board will allow reception over the 0-1.5 MHz range when programmed with RRM-7 Range Receive Modules. Since the filters in the antenna input of the TR-7 cut off below 1.5 MHz, the rear panel ANTENNA connector will not provide satisfactory operation in this range.

A separate VLF antenna input is provided on the rear panel ACCESSORIES connector for reception below 1.5 MHz (See figure 3-2). This input bypasses the built-in antenna line filters. A long wire or similar antenna connected to this input will provide satisfactory operation in this range, although receiver sensitivity will be somewhat degraded.

CAUTION

The antenna connected to the VLF antenna input of the TR-7 must be removed before attempting to transmit. In addition, an antenna connected to the VLF input will degrade receiver performance above 1.5 MHz.

Theory of Operation

The theory of operation of the TR-7 is discussed in the following paragraphs. Refer to figure 4-1, TR-7 Block Diagram, (foldout from pg. 4-5), for aid in following this discussion. The discussion is divided into three sections (receiver, transmitter, and frequency control) for clarity.

4-1. RECEIVER SECTION.

Incoming signals from the antenna pass through a bandswitched low-pass filter module, the transmit/receive antenna switching, and a bandswitched high-pass filter module. These filters create an input bandpass filter, the limits of which are defined by the yellow numerals on the front panel BAND switch. A separate receiver and/or receive antenna can be connected in this path by removing the jumper between the EXT RCVR and EXT ANT jacks on the rear panel and making the appropriate connections.

The output of the high-pass filter is connected to the input of the Up-Converter module, along with the VLF antenna input and the 25 kHz calibrator output. The VLF antenna is connected through a 20 dB attenuator due to the fact that the input antenna filters are bypassed by this input. Signals at the input of the Up-Converter module are mixed with the output of the synthesizer VCO to create a 48.05 MHz intermediate frequency (IF) signal. Conversion is accomplished by a high-level, double balanced mixer to provide a very wide dynamic range. The output of this mixer is amplified by a low-noise, high dynamic range junction FET amplifier to insure adequate receiver sensitivity. This stage is followed by a four-pole monolithic 48.05 MHz crystal filter. The purpose of this filter is to attenuate signals removed more than ±4 kHz from 48.05 MHz, thus protecting the remaining stages of the receiver from strong interfering signals. In this manner, optimum receiver dynamic range is preserved while providing excellent sensitivity.

The output of the Up-Converter module is routed to the input of the 2nd mixer module. This module provides additional gain at the 48.05 MHz 1st IF frequency and converts this signal to the 5.645 MHz 2nd IF frequency. Automatic gain control (AGC) voltage is applied to the 1st IF amplifier to supplement the control range supplied by later stages.

The 5.645 MHz signal from the 2nd mixer module is routed through the Noise Blanker module to the IF Selectivity module. When installed, the acessory NB-7 Noise Blanker acts on noise pulses prior to the IF crystal filters to prevent ringing in these filters from stretching the pulses. Maximum noise blanker effectiveness is thus assured. If the accessory NB-7 is not installed, the 2nd IF signal is passed through a jumper board in the same location for interconnection.

The IF Selectivity module contains provisions for 3 accessory crystal filters in addition to the standard 2.3 kHz filter. These filters determine the overall bandwidth of the receiver, and are selected by PIN diode switching controlled from the transceiver front panel. Careful attention has been given to the switching circuit design and physical layout of this module to minimize stray coupling paths which would degrade the ultimate selectivity of the receiver. The result is extremely high rejection of unwanted off-channel signals.

Following the IF Selectivity module, the 5.645 MHz signal is routed to the 2nd IF module. This module amplifies the 5.645 MHz signal and demodulates it using an AM or product detector, depending on mode. The demodulated signal is then amplified to a level sufficient to drive a speaker by an integrated circuit audio amplifier. AGC voltage, developed prior to demodulation, is used to control the gain of the IF stages. The same AGC signal is used to drive the S-meter circuit to provide signal strength indication. AGC decay time constants are selected by the MODE switch and front panel F/S switch.

4-2. TRANSMITTER SECTION.

In the transmit mode, audio signals from the MIC jack are applied to the Transmit Exciter module, where they are amplified and used to drive the balanced modulator and VOX circuits. The VOX section automatically controls the transmit/receive switching in the AM and SSB modes. A push-to-talk (PTT) input is also provided for manual control.

The 5.645 MHz double sideband output of the balanced modulator is routed through the Noise Blanker module to the IF Selectivity module. The signal is passed straight through the noise blanker for interconnection purposes only. The IF selectivity module rejects the undesired sideband, using the 2.3 kHz crystal filter. This is accomplished by correct positioning of the double sideband signal relative to the crystal filter.

The 5.645 MHz single sideband signal from the IF Selectivity module is connected to a summing amplifier on the 2nd IF module. In the SSB and RTTY modes, the signal is passed through to a variable attenuator. In the AM mode, the signal is summed with the BFO signal to create an AM signal before being passed to the variable attenuator. In the CW mode, the balanced modulator is disabled, and a **5.6458** MHz crystal oscillator is keyed to create an offset CW signal for application to the variable attenuator.

The variable attenuator consists of a PIN diode which is controlled by the ALC circuitry. The outputs of the forward and reflected wattmeter and the CARRIER control are connected to the ALC module. These signals are summed to create a controlling signal for the attenuator, thus controlling the transmitter drive level. VSWR protection is accomplished in this manner, as well as providing gain control to prevent flat topping and overdrive.

The 5.645 MHz transmit IF signal developed in the 2nd IF module is connected to the 2nd mixer module. The signal is converted to 48.05 MHz and amplified, then routed to the Up-Converter module.

In the Up-Converter module, the transmit signal is filtered by the 4-pole 48.05 MHz crystal filter to remove any spurious content, amplified, and converted to the operating frequency by mixing it with the output of the synthesizer VCO.

The output of the Up-Converter module is filtered by the high-pass filter module, and routed through the transmit/receive switching to the Power Amplifier module, where it is amplified to the final output level. The signal is then routed by the transmit/receive switching to the low-pass filter module to attenute the harmonics developed in the power amplifier. The transmit signal then passes through the wattmeter to the antenna jack.

4-3. FREQUENCY CONTROL.

The TR-7 features synthesizer control of the operating frequency. This allows the transceiver to cover a wide frequency range without the use of range crystals or other frequency determining circuits.

The reference for the synthesizer is generated by a 40 MHz crystal oscillator on the PBT/Reference Oscillator module. The output of this oscillator is divided by 80 to produce 500 kHz. These two signals (40 MHz and 500 kHz) are routed to the synthesizer modules, which are described later in this section. When the CAL switch is depressed, the 500 kHz signal is divided by 20 to produce a 25 kHz signal which is rich in harmonics. This signal is connected to the input of the Up-Converter module, and produces calibration marker signals at 25 kHz intervals.

The passband tuning controls are connected to a 13.695 MHz voltage-controlled crystal oscillator (VCXO) through a switching circuit. Control of this oscillator is thus switched between the front panel PBT control and the internal controls which are selected by the MODE switch. Although this oscillator is crystal controlled, it is designed to allow the frequency to be moved over a limited range (approximately ±3 kHz) centered on 13.695 MHz. This signal is then mixed with the 40 MHz crystal oscillator signal to produce 53.695 MHz, and with an 8.05 MHz crystal oscillator to produce 5.645 MHz.

The 53.695 MHz signal is used for injection to the 2nd mixer module, where it converts the 48.05 MHz IF signal to 5.645 MHz. The 5.645 MHz signal is used as a BFO signal for the generation and demodulation of SSB, CW, and RTTY signals. Since the 13.695 MHz oscillator is used to generate both signals, it can be moved in frequency without changing the receiver operating frequency. Therefore, as the BFO frequency is changed (by changing the PBT control voltage), the 53.695 MHz injection signal is changed by an equal amount. This allows the 2nd IF to be positioned anywhere within a ±3 kHz range with respect to the crystal filter passband while the receiver remains tuned to the incoming signal. This technique provides the passband tuning feature in addition to sideband selection.

Injection for the Up-Converter module is supplied by the VCO module. This module includes a voltage-controlled oscillator (VCO) which operates over the range of 48.05 MHz to 78.05 MHz. When mixed with the 0-30 MHz incoming signals, the result is the 48.05 MHz IF frequency. The VCO is tuned by a filtered control voltage derived from a phase detector which compares the frequency and phase of the 500 kHz reference from the PBT/Reference Oscillator module and a 500 kHz signal from the Translator module.

The Translator module combines the 40 MHz reference signal and the 5.05-5.55 MHz output of the permeability-tuned oscillator (PTO) which is controlled by the main tuning dial. The resulting 45.05-45.55 MHz signal is filtered and mixed with the VCO signal to produce a 3.0-33.0 MHz signal, depending on operating frequency. This signal is filtered, amplified, and applied to a programmable divider (÷ N) which is programmed by the Digital Control module. The output of the ÷ N is exactly 500 kHz when the VCO is tuned to the correct frequency, thus satisfying the phase detector and locking the synthesizer loop.

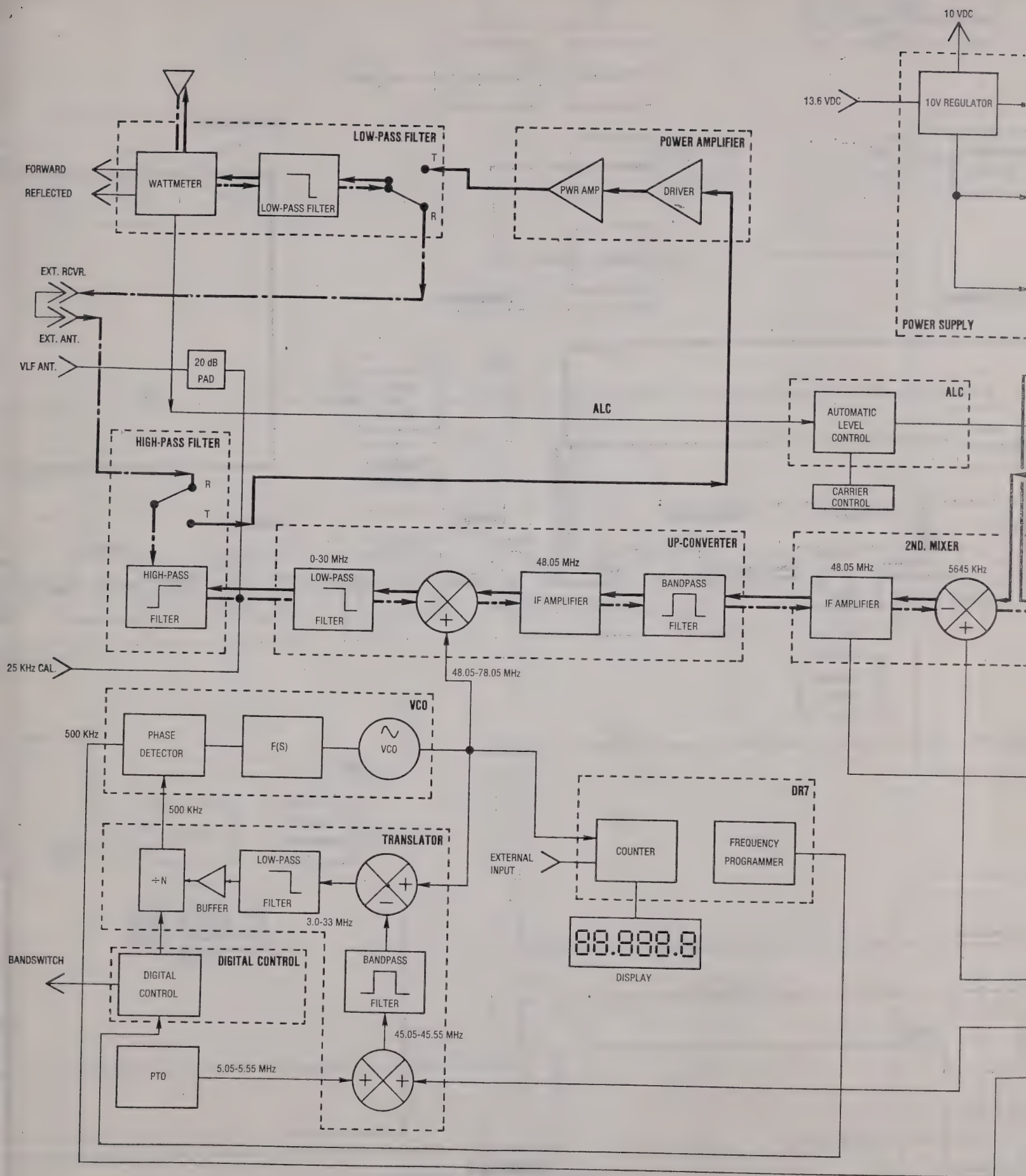
The Digital Control module generates programming information for the ÷ N by processing information from both the BAND switch and the frequency programmer on the DR-7 display module. The BAND switch information generates the proper ÷ N load number for the frequency range indicated by the white bandswitch numerals. The DR-7 frequency programmer is then used to increment this load number UP or DOWN by the desired amount.

The following example will help to illustrate the operation of the synthesizer:

Operating Frequency:	14.2835 MHz
	+ 48.0500 MHz
VCO Frequency:	62.3335 MHz
PTO Frequency:	
5.05 MHz + 0.2835 MHz =	5.3335 MHz
	+ 40.0000 MHz
Variable Reference Frequency:	45.3335 MHz
÷ N Input Frequency:	
62.3335 MHz -45.3335 MHz =	17 MHz
÷ N Output:	.5 MHz
(Load number = 34)	

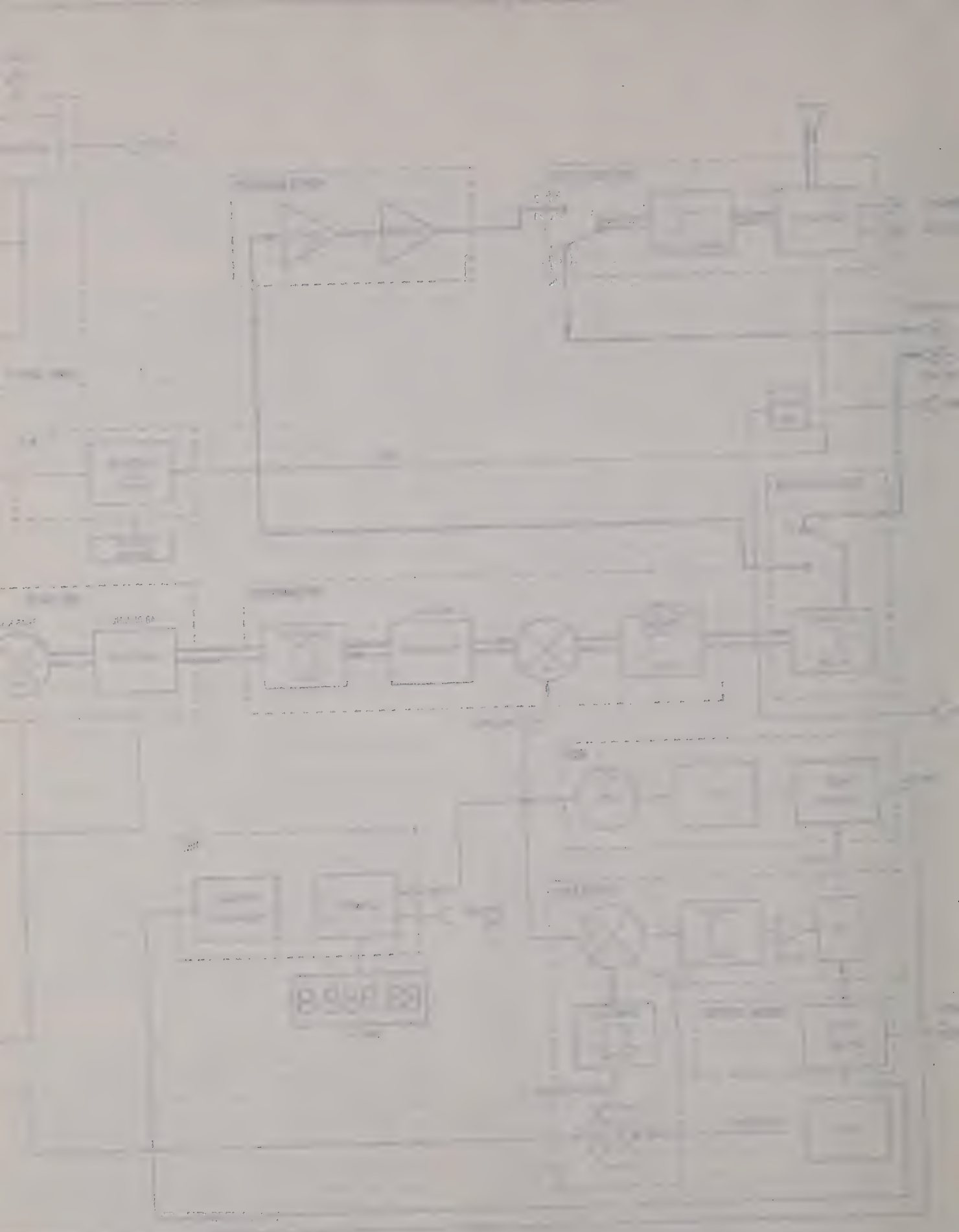
It can be seen from the above that each time the ÷ N load number is increased or decreased by one, the VCO frequency will be forced to change by 500 kHz to satisfy the phase detector and maintain a locked condition. By the same token, as the PTO is tuned, the VCO must follow exactly to maintain phase lock.

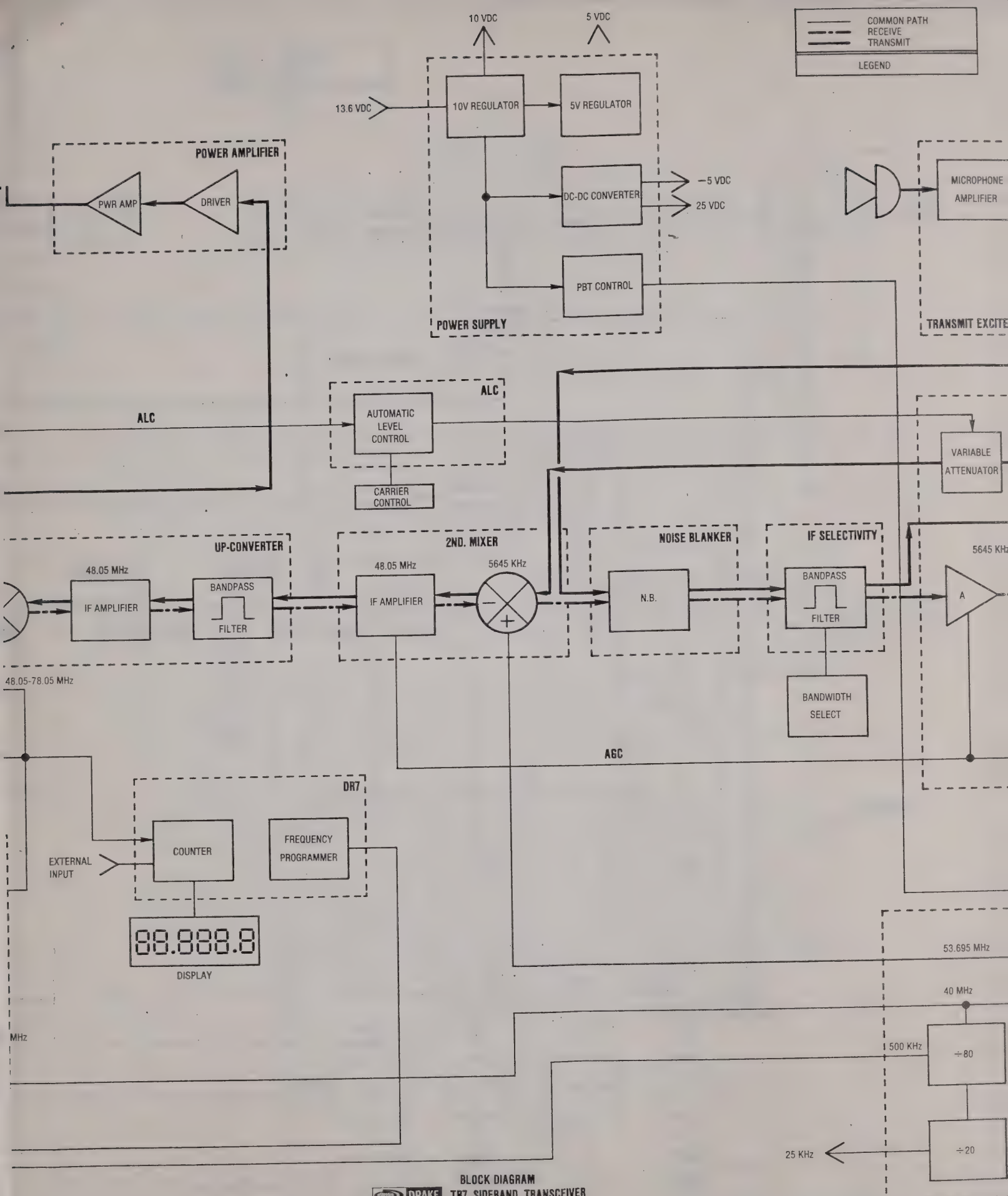
The DR-7 Frequency Display module contains a counter with a six digit LED readout. In the normal mode, this counter is connected to the VCO output and is programmed to subtract 48.05 MHz from the resulting count. In this manner, operating frequency is displayed on the LED readout. In the external mode, the 48.05 MHz subtraction is removed, and the counter input is connected to the rear panel counter input jack, resulting in a 150 MHz six digit counter for test purposes.



BLOCK DIAGRAM

DRAKE . TR7 SIDEBAND TRANSCEIVER





BLOCK DIAGRAM

DRAKE . TR7 SIDEBAND TRANSCEIVER

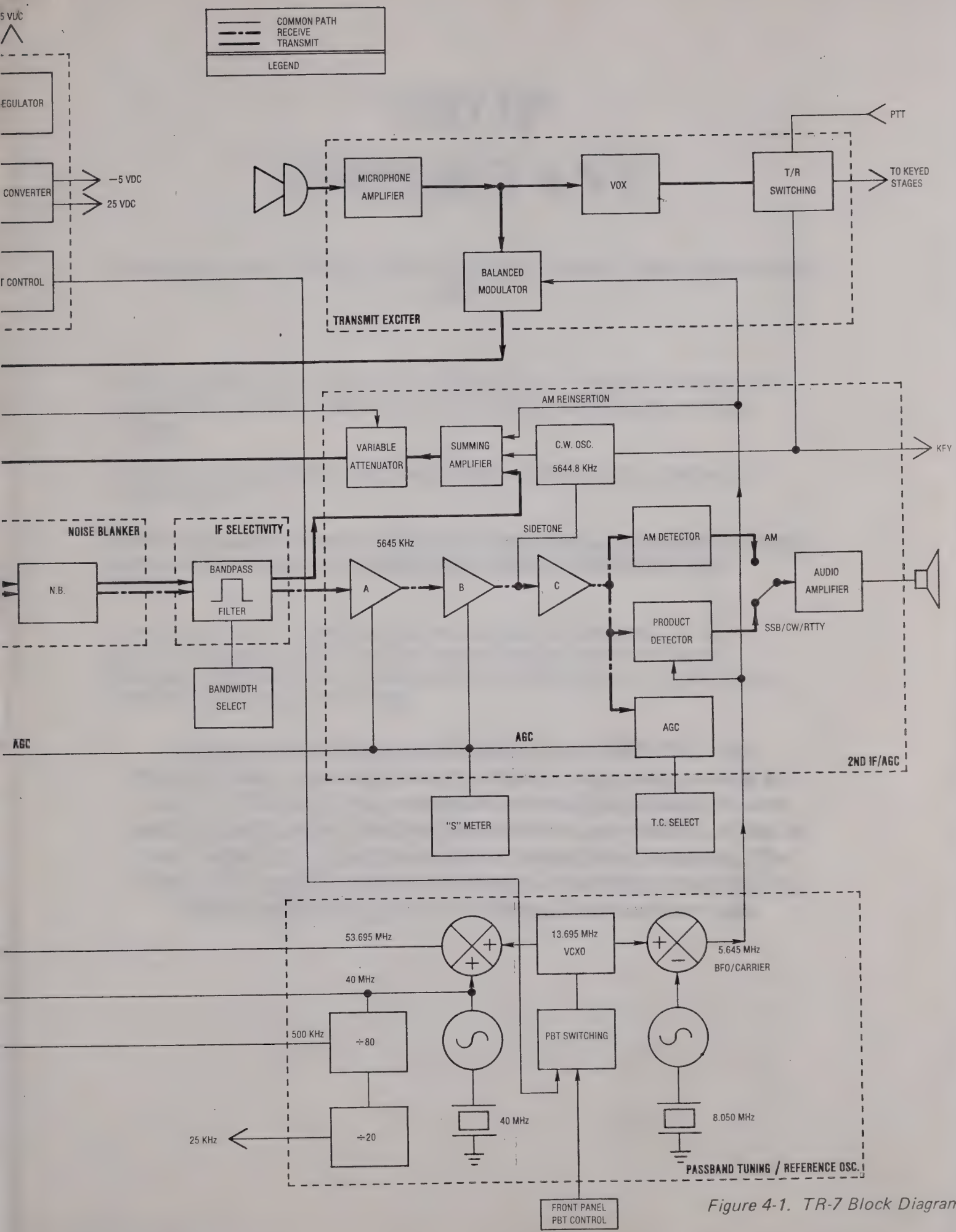
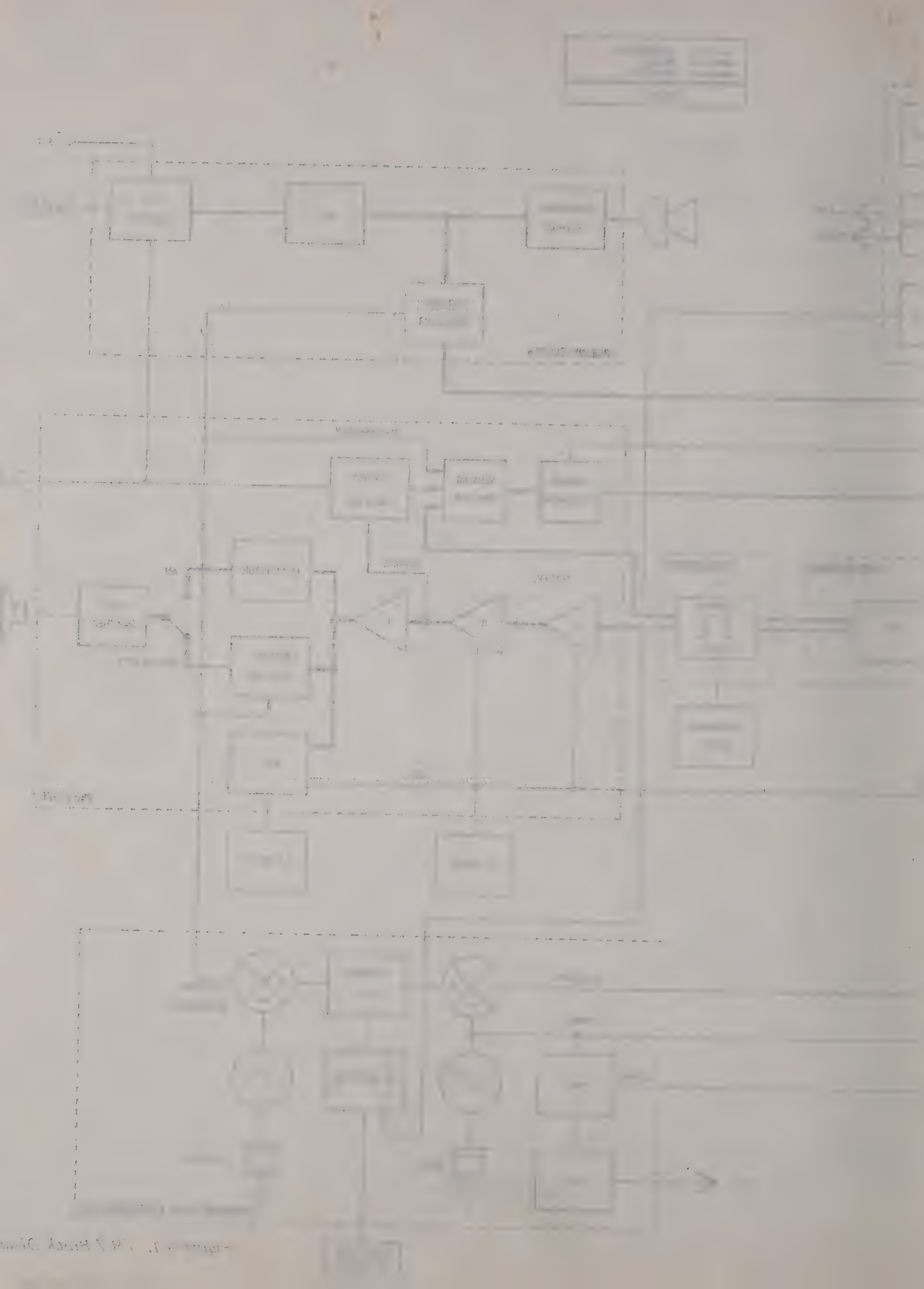


Figure 4-1. TR-7 Block Diagram



STOP
IMPORTANT

THE DRAKE AC-4 POWER SUPPLY CONTAINS LEATHAL VOLTAGES! IT CAN KILL!

IF YOU DO NOT HAVE THE TEST EQUIPMENT OR TALENT TO WORK ON THIS PROJECT, SEND THE KIT BACK FOR A COMPLETE REFUND! (less shipping)

THE BUILDER ASSUMES ALL LIABILITY AND RISK WHEN ASSEMBLING THIS PROJECT.

YOU WILL NEED TO RESET THE BIAS WHEN THE CONVERSION IS DONE. IF YOU DON'T, DAMAGE TO THE RADIO BEING POWERED WILL RESULT!

YOU MUST INSTALL THE PROTECTIVE COVER ON THE DRAKE AC-4 SUPPLY. PUSHING IT BACK INTO THE MS-4 SPEAKER IS NOT GOOD ENOUGH. THE ORIGINAL COVER WILL FIT THE DRAKE AC-4 EVEN WITH THE NEW PC BOARD ATTACHED.

Under no conditions will Mike Bryce, WB8VGE, The Heathkitshop, SunLight Energy Systems be responsible for your life! Since I have no control on the final assembly and testing, I will not be held responsible for your safety. If this is unacceptable, return the kit for a refund less shipping. The Drake AC4 upgrade kit comes with no warranty other than to replace defective parts for 90 days from invoice date.

Assembly notes for the Drake AC-4R replacement PCB

Some kits are supplied with either 120MFd @450vdc capacitors for C2 and C3 while some kits are supplied with 150MFd @450vdc. Either one is fine.

Some of the Drake AC-4 supplies don't use the same color code as given in the instructions.

DUE TO CAPACITOR SHORTAGES, SOME KITS HAVE THE 47MF CAPS SUBSITUTED WITH 100 MFD. THE SAME ONES USE IN THE LOW VOLTAGE CIRCUIT. NO DIFFERENCE WILL BE NOTED IN OPERATION.

When attaching the wires to the solder lug terminals, make a mechanically secure connection, then solder the connection.

Run the wires from the pcb through one or two of the old capacitor holes nearest the pcb pads. It makes for neater construction if you do.

Don't use cable tie wraps to hold the wires together.

When you tighten the hardware on the pcb, make sure you don't bend the leads of the bleeder resistors so they touch the nuts. This applies to the 200Ω resistors as well.

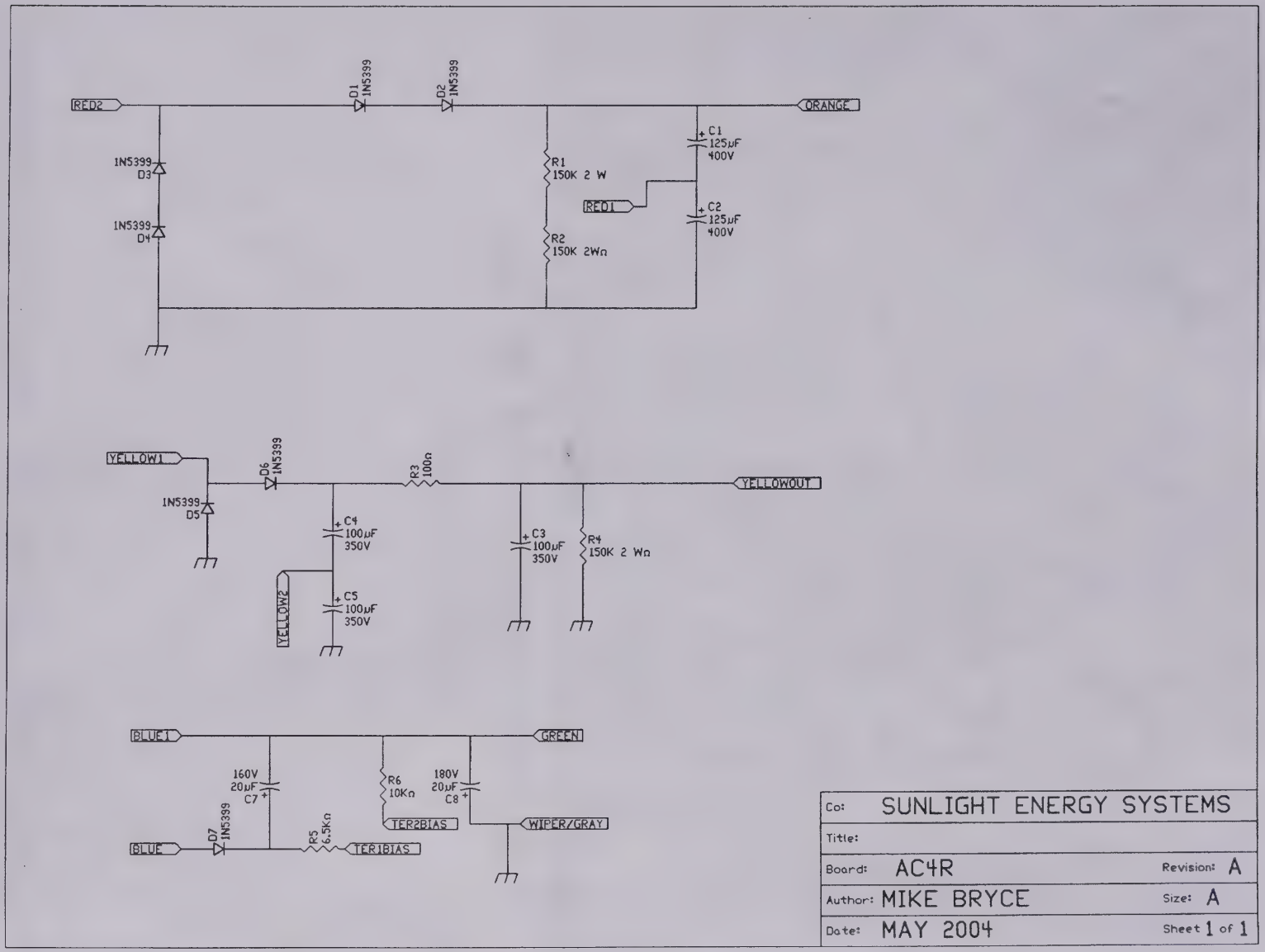
The pcb is correct and works as it is designed. If you have problems, more than likely it is a missed placed wire causing the trouble.

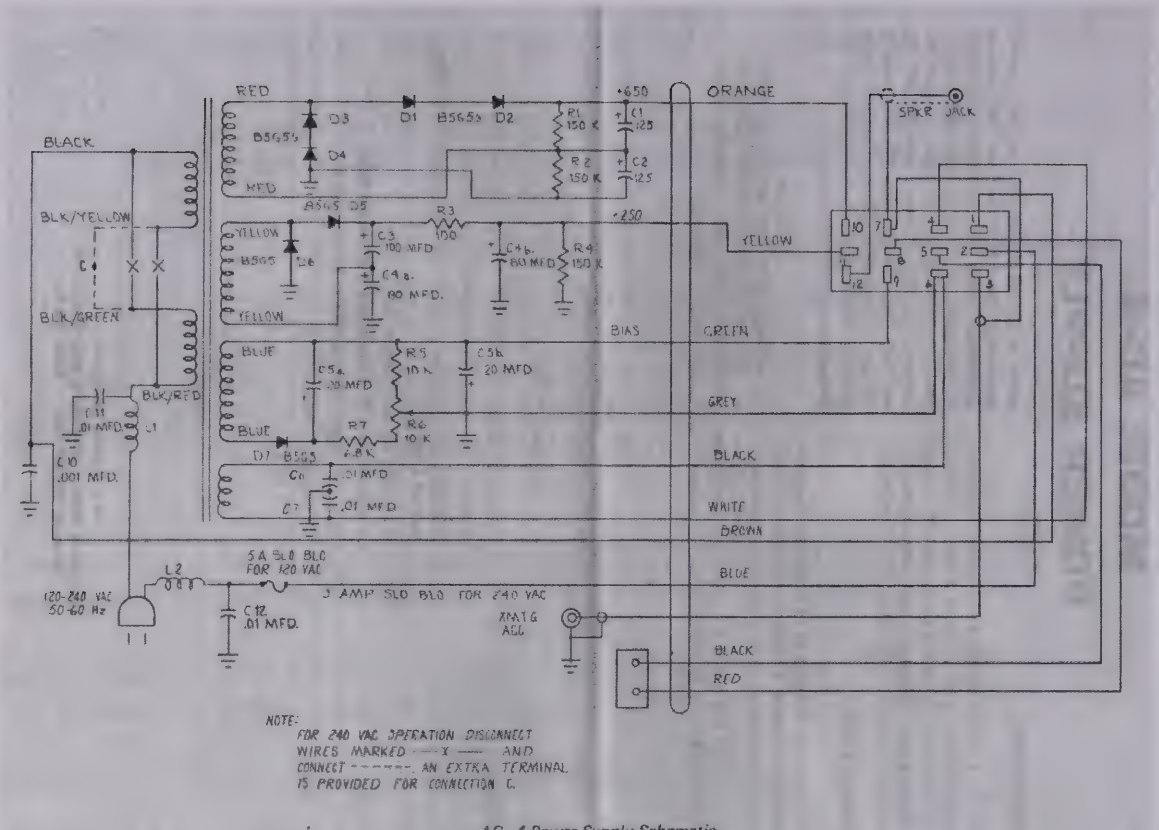
If you used the wire in the kit, all connection will be to the same color wire. The bias trimmer will have three white wires connected to its terminals. My wife is a goof. She wants to raise ground hogs.

Resistor R3 is shown as a single 100Ω resistor. It is in fact two 200Ω resistor in parallel.

The schematic shows the wiper/gray connection. The wiper is now white wire. All bias control wires are white.

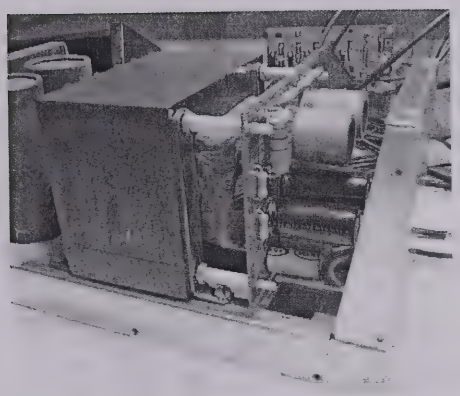
YOU MUST VERIFY THE VOLTAGES ON THE PLUG BEFORE CONNECTING THE POWER SUPPLY TO THE DRAKE RADIO! NO OR LOW BIAS VOLTAGE WILL DESTROY THE FINAL TUBES!


RED2
D1 1N5399
D2 1N5399
ORANGE
1N5399 D3
1N5399 D4
R1 150K 2 W
R2 150K 2Wn
RED1
C1 125µF 400V
C2 125µF 400V
YELLOW1
D6 1N5399
R3 100n
YELLOWOUT
1N5399 D5
C4 100µF 350V
C5 100µF 350V
YELLOW2
C3 100µF 350V
R4 150K 2 Wn
BLUE1
GREEN
160V 20µF C7
D7 1N5399
BLUE
R5 6.5Kn
TER1BIAS
R6 10Kn
TER2BIAS
180V 20µF C8
WIPER/GRAY
Co: SUNLIGHT ENERGY SYSTEMS
Title:
Board: AC4R
Revision: A
Author: MIKE BRYCE
Size: A
Date: MAY 2004
Sheet 1 of 1



AC—4 Power Supply Schematic

Courtesy: www.wb4hfn.com



Assembly Manual

For the

DRAKE

AC-4R REPLACEMENT POWER SUPPLY PCB

This new version of the AC-4R places all the components on a single PC board. This board is mounted on the side of the transformer. In addition to the new PC board, the expensive and hard to find replacement electrolytic capacitors used in the original have been updated to modern high temperature types.

Quick assembly guide for the AC-4R PC upgrade board

These instructions are for those that have burnt their share of Heathkit manuals in the past. This assembly guide is just short of step-by-step instructions,

Let's make some assumptions

- You know diodes can only be installed one way
- You can't use acid core solder
- You don't use a blow torch to solder the parts on the pcb
- Electrolytic capacitors can only be installed one way
- Some of the Drake AC-4 supplies don't use the same color code as given in these instructions.
- You have the test gear and talent to work on high voltage equipment such as this project
- When a step says to "install a part on the pcb" that means to place the part in the correct hole pads and then solder the leads to the pcb pads.
  After the solder has cooled, the remaining leads are clipped off. Protect you eyes from flying leads.

This project is broken down into several steps.

1. Assembly of the PCB
2. Removal of the old parts from the AC-4 supply
3. Installing the new PCB
4 Wiring the PCB to the remaining AC-4 supply
5 Testing the new circuit.
6 Trouble shooting

1. Assembly of the PCB

( ) Position the PCB down so the "CAUTION !! HIGH VOLTAGE PRESENT ON PC BOARD" is located at the top of the PCB .

( ) When installing the following diodes, be sure you have the banded end of the diode matching the silkscreen on the pcb. All diodes are mounted flush on the pcb. Make sure you have then pushed all the way down on the board before soldering them in place.

( ) The diodes will be installed first. The circuit uses all the same type of diodes. They are all 1N5399 high voltage diodes rated at 1.5 amps.

( ) While matching the diodes' outline on the pcb, install diodes at locations D1 through D7.

( ) When installing the following resistors, mount them so they are 1/4 inch above the pcb. This will allow for extra cooling of the parts. A pencil works great for spacing the resistors above the pcb.

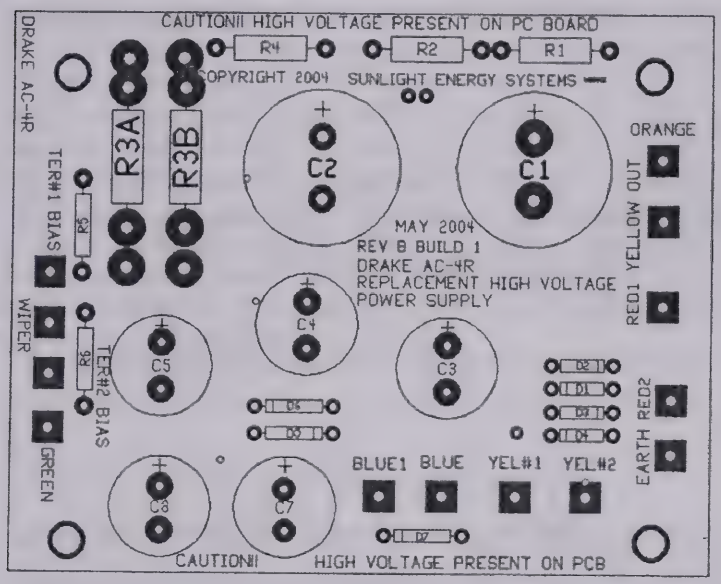
( ) Install three 150K (brn grn yel) 3 watt resistors at locations R1, R2 and R4

( ) Install two, 200Ω (RED BLK BRN) ohm five watt resistors at locations R3A and R3B. Be sure you have these resistors mounted at least 1/4 inch above the pcb.

Resistor R6 and R5 can be mounted flush on the pcb if desired, however feel free to space them above the board is you wish.

( ) Install 10 k (brn blk org) 2 watt resistor at location R6

( ) Install 6.8k (blu gry red) 2 watt resistor at location R5



The capacitors will be installed next. It is VERY important that the capacitors be installed correctly. If you put one in backwards, be ready for lots of smoke when you first apply power to the pcb.

Hint: when finished with the capacitors, all the negative leads go the same way. They all point toward the bottom edge of the board!

( ) Install two 125mfd @450v capacitors at locations C1 and C2 (these may be 150mf @450v)

( ) Install three 100mfd @350v capacitors at locations C3, C4 and C5

( ) Install two 47mfd @350v capacitors at locations C7 and C8.

This completes the assembly of the pcb. Set it aside until called for.

Prepping the transformer to hold the pcb

Unplug the supply from the 110 volt outlet. And if connected to your radio, disconnect the supply from the radio.

Remove the top cover

Remove the bottom cover

With a shorting stick, discharge all the capacitors you see.
Use your VOM to double and triple check that the capacitors are in fact discharged. Measure from chassis ground.

Located the four 8/32 aluminum standoffs.

You will notice that the transformer is held together by four rather long screws with nuts and washers. These screws go through the transformer. ***They are not the screws holding the transformer to the chassis!*** The idea is to screw the female end of the standoffs in the thread of the transformer's screws.

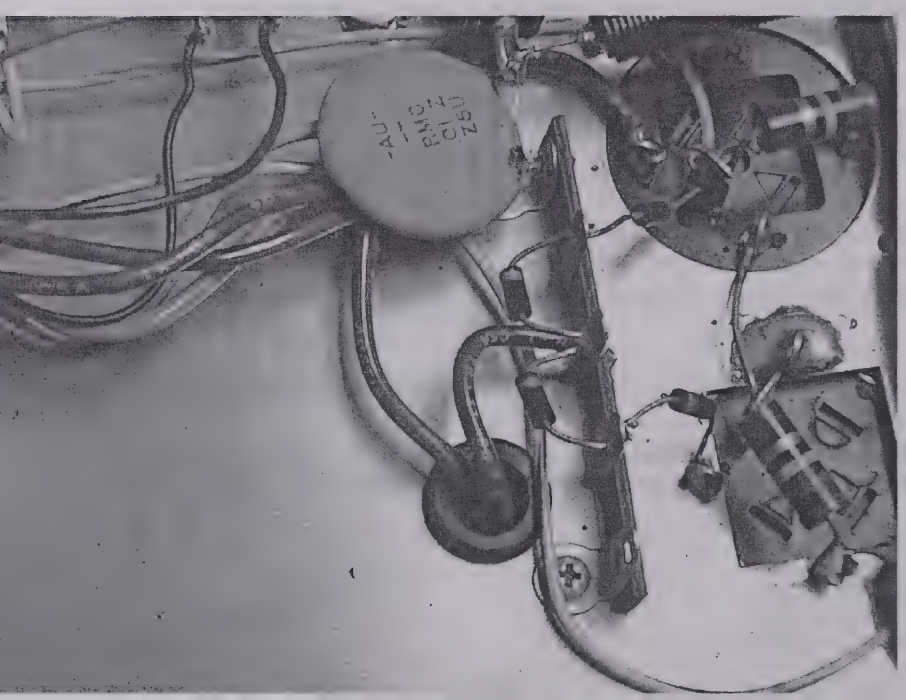
( ) Screw in the four standoffs on to the threads of the transformer's screws. Tighten. But do not over tighten the standoff. They are made of aluminum and may strip out if tighten too much.

There seems to be several flavors of the AC-4 supply. Not all the color codes are the same, and some terminals and standoff may or may not be present in your particular supply.

( ) Flip the supply over so you are looking into the bottom of the supply with the power cord and cable to the rig on the left side.

Remember, before you start cutting out parts, if you mess things up, it is your responsibility! Not that of SunLight Energy Systems.

You will be reusing some of the lugs on the two Drake installed terminal strips. It may be easier to use some solder wick to remove the excess solder from the lugs before you add the extra wires required. Or you can heat up the joint and then push in the new wire, and then resolder the joint.



THIS IS THE ORGINAL AC-4 WIRING

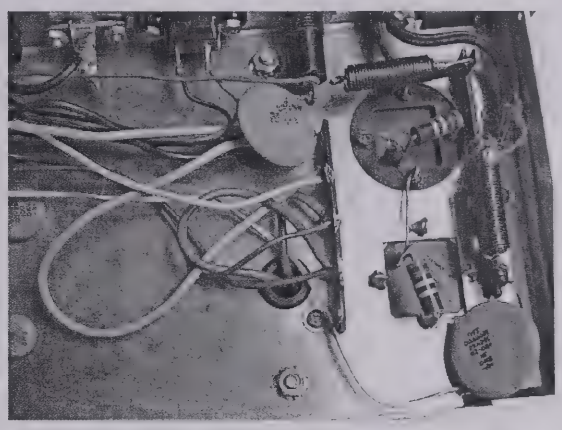
( ) At the top of the supply, there are four diodes mounted

to a terminal strip. Two on the strip, two going to the capacitors. Clip out all four diodes. Leave the resistors. Leave the capacitors in place. These parts comprise the +600 volt plate supply. These parts are not used. Leave them in for looks.

( ) Unsolder the one **RED** wire from the left most capacitor lug. Move this lead over to the second lug from the right on the terminal strip. Do not solder the wire at this time.

( ) Check your work! You should have two red wires on the terminal strip. One in the center, one on the second terminal.

( ) Cut the white/orange wire from the capacitor lead (capacitor on the left, with a 150k resistor attached) This wire will be connected to the pcb later. Right now, it goes to a single lug terminal strip just above the bias control.



AFTER CONVERSION

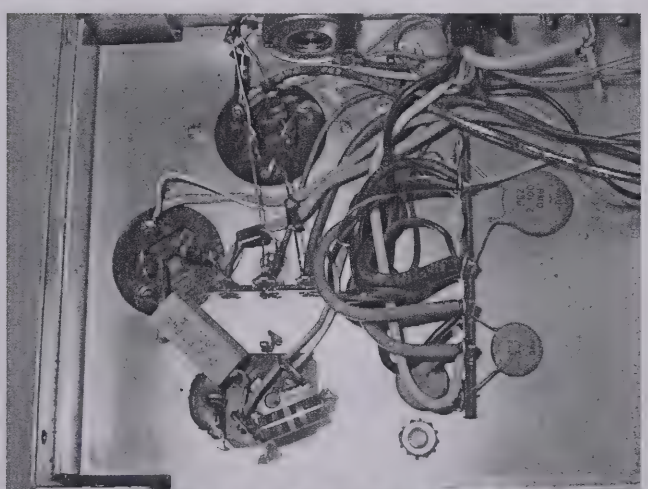
In the following steps, it is best to cut the resistor's leads and then heat the joint, and remove the old lead. The lugs on the bias terminal are fragile. If you break one off, you are in deep doo.

( ) Remove the two resistors connected to the bias control.

( ) Remove the ground lead from the bias control.

( ) Remove the large blue wire from the capacitor's terminal.

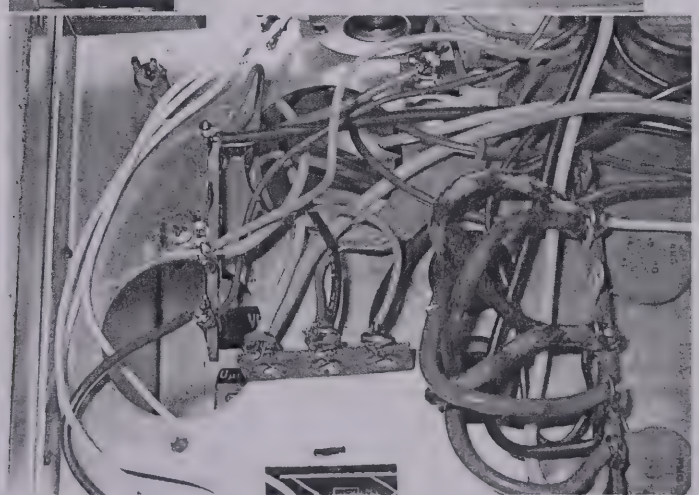
( ) Remove the small green wire.



This is the original bias and low voltage circuits.

To remove the old capacitors, use a pliers and twist the mounting tabs off. The capacitor can then be pulled out off the chassis. Some of the capacitors mount with two small metal tapping screws. Remove the screws (keep some for use later) and then remove the old capacitor.

( ) Clip out the diode and ground wire for the capacitor you just removed the two resistors from. Now remove the



the terminal strip between the two capacitors. There is one blue wire and one yellow wire connected to this terminal strip.

( ) Clip the yellow wire and white wire from the center capacitor

( ) Clip the wire on the large sand resistor (100Ω).

( ) Remove the center capacitor

( ) Clip out the other end of the large sand resistor (100Ω) and the 150k resistors. Clip out the small yellow wire and the remaining end of the small white wire. Clip out the small yellow wire.

( ) Remove the last capacitor

After the removal of the old caps and diodes/resistors

Check your work!

You should now have all three-bottom capacitors removed. The center terminal strip should have one yellow wire connect and one blue wire connected. A small gray wire is also connected to the ground (middle) terminal of this terminal strip. There will be one unattached large blue wire and one unattached large yellow wire and an unattached small green wire.

There should be no wires or components connected to the bias control.

( ) In this step, you will move the unattached LARGE YELLOW wire to the empty lug on the solder strip that holds the two LARGE RED wires. DO NOT CUT THIS YELLOW WIRE! Take the unattached LARGE YELLOW wire and place it on the second solder lug from the LEFT. This terminal strip should now have in this order, from left to right, capacitor to ground lug, LARGE YELLOW, LARGE RED, LARGE RED, unused ground lug.

( ) Locate the pcb assembly you had laid aside before.

The wires used to connect the pcb to the AC4 are supplied with the kit.

( ) Solder **two blue wires and two yellow** wires to the pads on the bottom of the pcb. Make sure you trim off any excess wire leads from the pcb. (Hint: Fold the yellow and blue wires into a single loop, solder both ends. Then cut to length the wire you need, keeping the rest four use later when called for.)

The pcb mounts so the three 150K resistors are on the top.

( ) Mount the pcb assembly to the four standoff you have already installed on the transformer using a washer and nut. The washer goes on first, then the pcb then the nut. Tighten the hardware down. DO NOT over tighten the hardware.

( ) Route the four wires (two blue, two yellow) though one of the old capacitors holes.

( ) BEFORE mounting the extra terminal strip in the next step, you may want to cut off or bend over the ground lug so you don't solder wires to this lug. Mount the extra terminal strip provided in the kit to one of the old capacitor holes using one of the old capacitor mounting screws. Mount this terminal strip to the mounting holes in the bottom most center capacitor hole.

( ) Connect one yellow wire from the pcb to the LARGE YELLOW wire on the small three lug terminal strip. Solder

( ) Connect the yellow wire from the pcb to the LARGE YELLOW wire on the top terminal strip. (this is the strip with the two LARGE RED and one single LARGE YELLOW wire)

( ) solder one blue wire from the pcb to the large blue wire already attached to the small three lug terminal strip.

( ) Connect the other large loose blue wire to the next lug on the new terminal strip. Now, attach the last blue wire from the pcb to this lug and solder.

You now should have both large blue wires and both large yellow wires attached to their counter parts going to the pcb.

( ) Now, run a red wire from either red wire that is soldered to the terminal strip at the top of the supply. Run that wire to the pad on the pcb labeled RED2.

( ) Run a second red wire from the remaining red wire on the terminal strip to the pad labeled RED1 on the pcb.

( ) Locate the white/orange wire that is attached to the single lug terminal strip. Route this wire to the pad labeled orange on the pcb.

( ) Install the small yellow wire on the next lug of the new terminal strip. Run a yellow wire from this lug to the pad labeled yellow on the pcb.

( ) From the pad labeled EARTH on the pcb, run a black wire from this pad to the center lug of the three terminal lug. Solder. (this is the terminal strip with the large yellow and large blue wires attached.)

( ) Run a ~~white~~ brn wire from the pad labeled WIPER to the center lug of the bias control. Solder

( ) Run a ~~white~~ gry wire from the pad labeled TER#1 to ~~one of~~ the outside lugs of the bias control. closest to the chassis

( ) Run a ~~white~~ grn/wht wire from the pad labeled TER#2 to the last lug on the bias control.

( ) Connect the small green wire to the last terminal on the new terminal strip. Solder a green wire from this lug to the pad labeled GREEN on the pcb.

Check your work

All the pads on the pcb should now have a wire attached. Make sure the wire colors match the pad names.

There should be no loose wires under the chassis. All color coded wires should match.

There should be NO wires attached to the ground lug on the terminal strip you installed.

The hardware holding the pcb should be installed and tight.

All connections to the two terminals should be soldered. Check for stray wires touching other lugs or to the ground lug.

Testing the AC-4R supply

The power supply contains voltages that can and will kill you if you get in contact with them.

If you are not able to test this supply or do not have the necessary test equipment, then STOP! Either find the necessary gear or person to help with the following steps. Keep one hand in your back pocket to avoid touching ground.

DO NOT CONNECT THE SUPPLY TO THE DRAKE RADIO EQUIPMENT AT THIS TIME

You need to short out two wires to allow the supply to power up without connecting it to a Drake radio. *THERE IS NO WAY TO TELL IF THE SUPPLY HAS 110 POWER APPLIED TO IT.*

On the large connector, those two pins are #1 and #2. You can use a short piece of insulated hook up wire to short the two pins together. Place some tape across the small jumper to keep it in place.

You can also connect the BLUE and BROWN wires together. These two wires are on the primary side of the transformer and NOT the blue wires used in the bias circuit.

Before you begin testing, make sure your VOM can safely measure 1000 vdc and the test leads are in good condition!

High voltage +650 volt test

( ) Preset your vom to read 1000 vdc. Attach the negative lead to the chassis and the red lead to the orange wire located on the single lug terminal strip. The white/orange wire connects to this point, too.

HINT: YOU CAN MEASURE THE VOLTAGES FROM THE PADS ON THE PCB.

With the jumper across pins 1 and 2, as soon as you plug in the supply, it will power up!

( ) Plug in the supply. If you hear cracking, snapping or smell or see smoke, remove the power cord from the supply at once!

( ) The ORANGE wire should read at least 650 to 750 volts.

( ) The YELLOW wire should be at least 290vdc

( ) The GREEN wire is the bias and its value will vary as you adjust the bias trimmer. (remember, bias voltage is minus when referenced to ground!)

These voltages are from an unloaded supply. They may vary as much as 20% and be within limits.

( ) Remove the power cord from the 110 volt source

( ) Remove the jumper from pins 1 and 2

If the supply passes the above tests, install the top and bottom covers. Next, proceed to the bias setting instructions in your user manual.

You must now reset the bias control as per the Drake instructions for the transmitter or transceiver you have. Use the bias setting instructions supplied in your instruction manual.

Trouble shooting

• No output on Any voltage test points	When testing the supply, make sure pins 1 and 2 are Connected together. Bad fuse. Incorrectly wired cable. No primary power at wall.
No 650v output	Red wires not connected to the pcb correctly. Red wire Not soldered on terminal strip. Diodes D1 through D4 Installed incorrectly or defective. Orange wire not Soldered to terminal lug
650v supply low	Diodes D1 though D4 installed backwards capacitors C1 or C2 not soldered on pcb or defective
Fuse blows when power applied	Remove red wires from pcb. Test. If fuse blows, Remove yellow wires from pcb. Test. If fuse blows A short exits in the secondary high voltage or low

	Voltage wires. If the fuse blows when the red or Yellow wires are connected to the pcb. Then The problem is a shorted diode or capacitor installed Backwards.
Low 250v	Diodes D5 or D6 defective or installed backwards Capacitors C3, C4 or C5 defective or installed Backwards
Low or missing bias	Diode D7 backwards. Capacitors C7 and C8 backwards. Error in chassis wiring

Trouble shooting tips:

If you have trouble with the high voltage supply, then check the secondary of the transformer that is supplying that voltage to the pcb. If you have ac going in but no dc coming out, there is a problem on the pcb assembly. On the other hand, if you do not see any ac coming in, then there is a wiring error between the transformer and pcb assembly.

Remember, the circuit is a voltage doubler, so on the high voltage input, the ac input will be half the dc output.

Use this trouble shooting tip on the other supplies on the pcb.